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The World's Tin
Richard H. Tingley

Improving North American Sea Ports for World Trade
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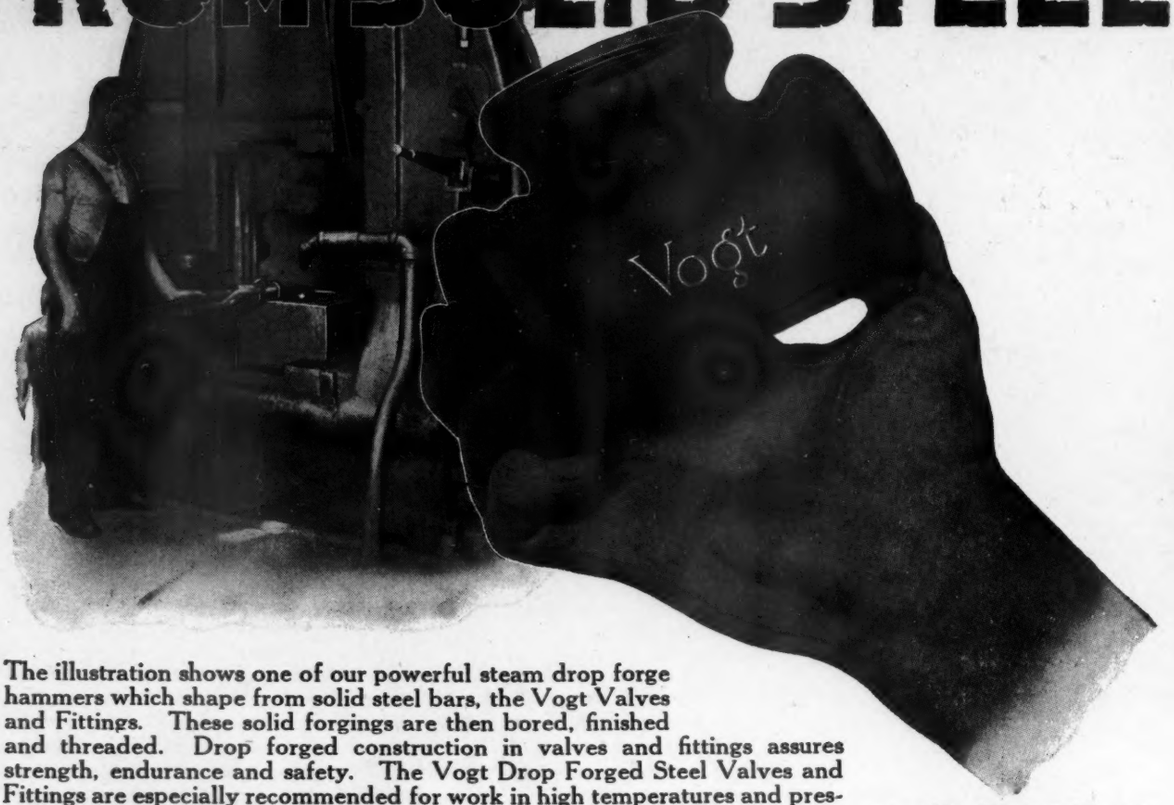

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FEBRUARY, 1922

The World's Tin

A Story of Tin Mining, Smelting and Marketing the World Over With a Brief Early History of the Metal

By RICHARD HOADLEY TINGLEY

THE USE of tin dates back to the most remote antiquity. As early as the eighteenth Egyptian Dynasty, coins, tools and implements containing about ten per cent. of tin, were in use. Babylonian, Assyrian and Egyptian bronzes testify to the fact that this metal was well known to ancient civilizations. It is probable that a knowledge of tin antedates written or recorded history and that its use, together with that of copper and gold, begins with the dawn of civilization. Upon the authority of "Ure's Dictionary of Arts, Manufactures and Mines," the ancients had discovered that an alloy of copper and tin was harder than copper alone. Most of the weapons and utensils made from the alloy, however, were cast rather than forged as afterwards became the practice.

Nearly all the tin of ancient days came from Cornwall, England, where it was obtained by the Phoenicians and brought into Africa, Asia and Greece. Phoenician workings of the Cornish mines are said to have begun as early as the Twelfth Century B. C., and their domination of this trade which they carefully guarded against outside interference, lasted for many centuries. Cornwall remained almost the only source of the world's tin until about the middle of the Thirteenth Christian Century, and practically controlled the field for several centuries afterwards.

Cornwall has always been, and still is, under the handicap of abnormal mining expense. The tin bearing lodes occur many hundreds of feet deep and incursions of the sea, together with the great depth of the workings have always, even in ancient times, been a serious drawback to their development and these difficulties still continue to operate against their economic production. Subsequent discoveries of surface tin deposits in many parts of the world are responsible for the decline of the Cornish industry after so many years of dominance. It has been unable to compete with the cheaper methods of obtaining the ore and has long since fallen into the ranks of the lesser properties, producing at the present time only about 2½ per cent. of the world's annual output.

FOR CENTURIES Cornish mines were the world's chief tin producers. During the last generation or two, however, Cornwall has relinquished its position in tin production.

Obtaining ore from lodes hundreds of feet below the surface, in tunnels and shafts reaching miles away from the mine openings and extending far out under the sea, it has been unable to compete with properties more avantageously located.

The Malay Peninsula and the Dutch East Indies, with their surface mines, now rank where Cornwall once stood and, more recently, Bolivia is coming to the front with its lode ores.

Unlike Cornwall and the Dutch East Indian ores which are smelted at or near where they are mined, Bolivian ore concentrates are shipped to the United States and to Europe for refining, there being no smelters in that country.

The World's Production of Tin

Prior to 1914 tin production had steadily maintained itself at about 100,000 to 110,000 tons annually. The peak of production was reached in the year 1917 when the output was 125,223 tons, falling off again to 116,385 tons in 1919. Recovering somewhat in 1920, production reached 118,411 tons as will be seen by reference to the following table.

THE WORLD'S PRODUCTION OF TIN
(In Tons of 2,240 Pounds)
From "Mineral Industry."

	Tons		Tons
1914.....	111,506	1918.....	122,513
1915.....	113,319	1919.....	116,358
1916.....	115,306	1920.....	118,411
1917.....	125,223		

By far the greater portion of the world's tin supply now comes from alluvial deposits where the ore is mined in open cuts—"Open-cast" mining the English term the operation—and the Malayan Peninsula is, and for some time, has been the chief producer. Banka, Billiton and Singkep in the Dutch East Indies run a close second along with Bolivia in South America. In the former, mining is conducted almost exclusively in open cuts, while Bolivian ores are mined in lodes deep in the ground. Siam, China, Nigeria, Australia, Cornwall, South Africa and Spain follow in about the order stated.

Malayan Tin (Straits Tin)

Up to about the year 1914 the Malay Peninsula supplied about half of the world's tin each year. Since that time the output has been gradually falling off so that, in 1920, a little less than 30 per cent comes from that locality. Malay still continues, however, to hold its place as the world's largest tin producer.

MALAYAN PRODUCTION OF STRAITS TIN
(In Tons of 2,240 Pounds)
From "Mineral Industry."

	Tons		Tons
1914.....	49,042	1918.....	37,370
1915.....	46,766	1919.....	36,867
1916.....	43,870	1920.....	34,928
1917.....	39,833		

The Malay Peninsula has long been regarded as a land rich in minerals of all kinds and

Netherlands Chamber of Commerce.

General view of mining operations of the Singkep Tin Co. in the Dutch East Indies, about 100 miles south of Singapore, and directly under the equator. The natives have reached the ground in which the tin ore is found and are washing it out by means of a hydraulic jet. All the tin mines in the Dutch East Indies are government owned with the exception of those on the islands of Singkep and Billiton, which are owned by private companies.

Open cut operations at Mine No. 38, Koba, on the Island of Banka. Koba is on the east coast of Banka. The photograph shows the method of raising the ore out of the open pit to the surface where it is concentrated. The ore is lifted out of the mine by means of an endless belt hauling the ore up the steep grades. Since this mine, like other mines in Banka, is excavated to a great depth, pumps are kept constantly at work keeping it dry.

Thousands of pigs of tin awaiting transportation from the Soengeiliat mine and smelter to the market. It is apparent that pigs of tin do not deteriorate by exposure to the weather that outdoor storage is perfectly feasible.

has frequently been quoted as the "Golden Chersonese" of the ancients. Whether this be true or not, for more than a century the tin deposits of the peninsula have been worked and tin exported. It is claimed by some writers that much of the tin used in the most ancient bronzes had its origin in Malaya. Indications of very ancient workings have been found and the Chinese have, for more than a hundred years, operated in certain of the districts. They were the pioneers who, under the old Malay rule, subject to extortion by every petty Malay prince and in the face of great handicaps and difficulties, proved the richness of these lands and started the peninsula on its way to mining prosperity.

Malayan Tin Mines

There are four methods employed in tin mining in Malaya; open cut workings, underground alluvial mines, hydraulic or dredging operations and deep lode mines. By far the greater part of tin mining is carried on in open cuts, a method originally introduced by the Chinese. Describing the operation Messrs. Kelly and Walsh of Singapore write substantially as follows:

The work of removing the over-burden is usually done by contract. When the "karang" or tin bearing gravel is reached it is lifted by coolies into wash boxes for separating the tin from the gravel. The boxes are coffin-shaped, of length from ten to twenty feet, and are set on a grade of about one in twelve. They are from three to four feet wide in the widest part, gradually narrowing at the end to ten or eighteen inches. At the widest part a baffle-board is fixed eight to twelve inches deep, over which a portion of the water falls, and at the side upon which the "karang" is deposited, a square aperture is cut, through which a stream of water constantly flows. The "karang," being caught up at the baffle-board, is then turned over and over by coolies using long handled hoes; tossed, turned and agitated. When the box is filled, the stream through the side is shut off and the tin lifted out and placed in tubs or buckets for transport to Singapore or Penang for smelting. Many of the larger open cut mines are supplied with modern pumps, steam-shovels, air plants, conveyors and other labor saving devices, although in some of the small mines the operations are crude and primitive.

Open cut mines can be operated economically to a depth of about 50 feet before mechanical haulage is necessary. There are many open cut mines working at a depth of 100 feet and more using various forms of mechanical lift and haul—belt conveyors, endless chains, gears, ropeways, etc., but the most popular and economical system is the inclined tramway with trucks which are loaded and unloaded by Chinese or Tamil coolies.

Underground alluvial mines are deposits where the "karang" is too heavily over-burdened to admit economical open cutting. In these, shafts are sunk at regular intervals until the pay dirt is reached, and cross-cuts and tunnels of the ordinary type are driven to connect the various shafts. The "karang" is raised to the surface by some form of mechanical lift. Mining is frequently carried on by

this method to a depth of 250 feet. There are instances in Malaya, as in the case of the Tambun mine, where an underground mine has, after long operation, been converted to an open cut.

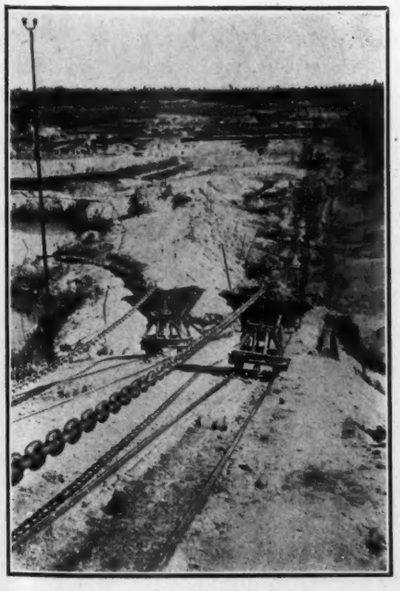
Mr. W. Eyre Kenny, Senior Warden of Mines of the Federated Malay States has listed the mines of that peninsula, classifying them with regard to their manner of working. His tabulations show that there are 43 open cut mines, 24 alluvial underground workings, eight using dredging operations and nine lode mines—84 in all—from which in 1920 there was mined, 586,905 piculs of tin, amounting to approximately 25,000 long tons. (One picul equals 133⅓ pounds.)

Many of the larger Straits mines are British owned and are equipped with every device for labor saving. The Pahang Consolidated Company, Ltd., has an installation of an electrically driven air compressor with capacity of 2,500 cubic feet of air per minute, two six inch electrically driven pumps, four Babcock and Wilcox boilers, ten James concentrating tables, 24 miles of railway and about fifteen miles of tram.

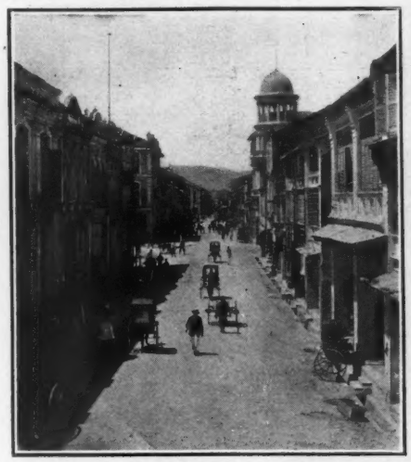
The decline in production of Straits tin has been so steady and so marked as to create much comment and speculation as to the future. It is generally attributed to the fact that many of the older workings have largely exhausted their areas of gravel which can be economically mined under their present methods of operation, and have hesitated about making new installations of machinery under existing conditions. Nobody doubts the existence of large quantities of Straits tin but, in view of the present market, mine owners do not feel justified in spending the money necessary to get it.

Bolivia Second Largest Producer

Bolivia has gradually worked itself up to second place in the world's producers of tin. Unlike most other tin producers, however, its operations are all in deep lode mines there being practically no alluvial placer mining in that country. Unlike most other tin producing countries, also, Bolivia has no smelting plants and its ore concentrates are all shipped to other countries for smelting and refining.



Tin mining operations at Mine No. 23, Soengeiliat, on the island of Banka, showing the method of lifting the ore from the mine to the surface by means of a counterweighted railway.



A street scene in Penang, Straits Settlements. This is the second largest Malayan city and enjoys the reputation, along with its sister city Singapore, of having plants with the largest smelting capacity of tin in the world, and is situated on the edge of the chief tin producing Malayan state, Perak. Singapore has often been called the "Gateway of the East," or the "Melting Pot of Asia." The same term with almost equal propriety, may be applied to Penang for in moving about its streets, one may see natives of every country under the sun, and hear a confusion of tongues and dialects equal to that which put a stop to the building of the Tower of Babel.

The development of tin mining in Bolivia began about the year 1895, and tin mining is now its most important mining enterprise. The principal fields are in the Cordillera de las Tres Cruces; in Quimsa Cruz in the Inquisivi Destrict in the Department of La Paz near the City of Potosi, and in the Province of Sur Chicas. There are also important mines at Araca, Caracoles, Colquini and Monte Blanco. The richest ores usually run from six per cent to eight per cent tin and the concentrates—called "barilla" contain from 50 to 70 per cent. metallic tin. The most common ores are dioxides accompanied with peroxide of iron, and cassiterite (stannic acid). At Potosi tin is found with yellow oxide of antimony.

According to W. L. Schurz, in his "Bolivia, a Commercial and Industrial Hand Book," (1921), tin mining methods in Bolivia are very defective, and in places, crude in spite of the marked improvement in some of the large plants, as at Patino and Llallagua. Too little effort, he says, has been made to work the veins with regard to future productivity, the aim being to secure the largest and quickest returns.

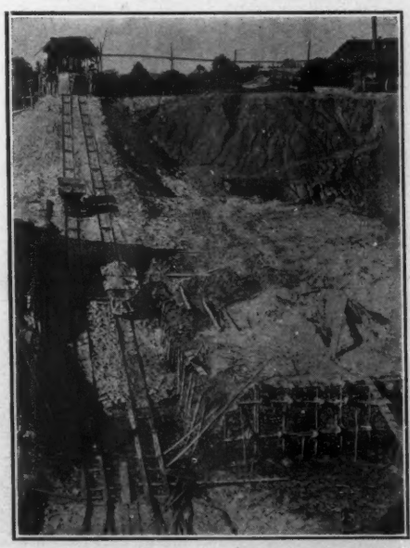
In 1918 tin accounted for 70 per cent. in value of Bolivia's exports, the duty in that year amounting to 89.5 per cent of the total volume of all export duties. Prior to 1915 practically all Bolivian tin ore concentrates were shipped to Europe for smelting. With the erection of two large smelting plants in the United States since that time, however, this country absorbs the greater quantity of these ores.

Tin in the Dutch East Indies

The principal deposits of tin in the Dutch East Indies are on the islands of Banka, Billiton and Singkep, lying to the east of Sumatra in the Straits of Karimata. Tin mining at Banka dates back as far as 1710 when it was carried on by the Malays and afterwards by the Chinese. In 1820 mining came under European control through the Dutch East Indian government and since 1852 has been supervised by European engineers. According to the Yearbook of the Netherlands East Indies (1920), there have been important improvements recently made in all mining, smelting and other operations; in draining the open pits, and in stoping the over burden so that the Banka tin industry is now fully up to date making use of the latest technical developments. Moreover, during the past few years, tin has been subjected to chemical test before exportation, so that the stamp of Banka tin guarantees the quality of the product. Banka is independent of other countries for the smelting of its ores and has a most complete smelting and refining plant of its own belonging to the government.

The ore is worked almost exclusively in open pits in the alluvial deposits of many rivers and in the alluvial strata on the hill slopes. Most of the labor is done by Chinese coolies. The average number of laborers in 1918 was 18,658. Since 1914 Banka tin has been sold almost exclusively in the Dutch East Indies and in Holland, although arrangements are now being made for its more extensive importation to the United States. In 1910 there were 13,840 tons of tin from Banka sold in Holland and none in the Dutch East Indies. In 1914, 9,857 tons went to Holland and 2,278 tons to the Dutch Indies. In 1918, 12,055 tons were sold in Holland and 10,934 in the East Indies. The average number of working mines in Banka in 1918 was 350. In 1920 Banka mined 14,320 tons of metallic tin.

The Singkep Tin Company owns the principal mine on the island of that name. Most of the mining is done in open cuts although there is some lode mining carried on in the hills. A unique feature in this island is that rich ore is found in the bottom of the sea nearby and

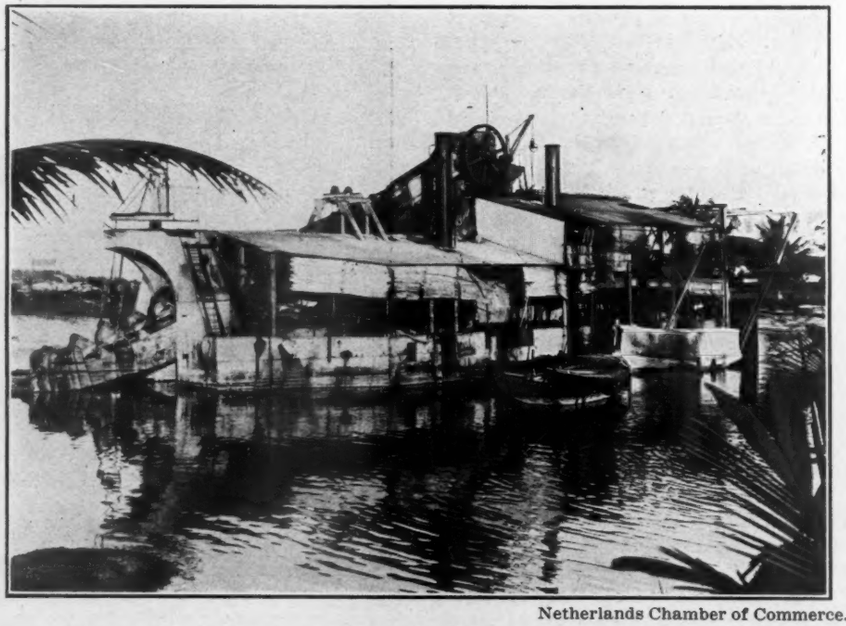


Mine No. 14 at Blinjoe, on the island of Banka showing tin ore being raised to the surface for concentration by means of a counterweighted railway.

Netherlands Chamber of Commerce.

Unique bamboo bridge over the Seraya river, Java, showing that the natives have an unusual degree of engineering ingenuity in their methods of bridge construction.

Prospecting for tin ore at the bottom of the sea off the coast of Banka at Pangkalpinang. The alluvial deposits of tin ore on the island have in many cases been washed far out to sea and their reclamation is profitable. The ore is partly concentrated on the dredges before landing on the shore. This operation of dredging tin ore from the bed of the sea is also performed in other parts of the Dutch East Indies, notably at Singkep.



Netherlands Chamber of Commerce.

Tin dredge of the Singkep Tin Mining Company.

is worked by dredging operations. The mud is brought to the surface and preliminarily concentrated on board the dredge. It is then, often, further worked on shore, and, like the concentrates of Billiton, sent away for smelting—usually to Singapore which is but a short distance away across the straits. In 1918 Billiton produced 6,945 tons and Singkep 514 tons of tin.

Tin in the United States

As a producer of tin, the United States is a negligible factor. Practically all the American tin is mined in Alaska and the concentrates smelted in this country. Very small quantities of tin have, from time to time, been taken from ores in Nevada, both of the Carolinas, South Dakota, New Mexico, Washington and West Virginia. In no year, however, has the quantity exceeded a few tons. The Alaskan mines are now producing not more than 60 or 70 tons a year.

The United States consumes practically one-half of the world's tin output as will be seen by reference to the following table:

UNITED STATES IMPORTS OF TIN

From "Mineral Industry"

	Tons (2,240 Lbs.)		
1906	45,101		
1907	36,852		
1908	36,831		
1909	42,562		
1910	46,936		
1911	47,739		
1912	51,787		
1913	46,554		
1914	42,432		
1915	51,176	Tin Ore	
1916	66,624	8,284	
1917	68,959	7,218	
1918	73,473	14,654	
1919	50,331	15,302	
1920	72,350	25,754	(11 mo.)

CLASSIFICATION OF PRINCIPAL TIN IMPORTS INTO UNITED STATES IN 1920

(In Tons of 2,240 Pounds)

From New York Metal Exchange

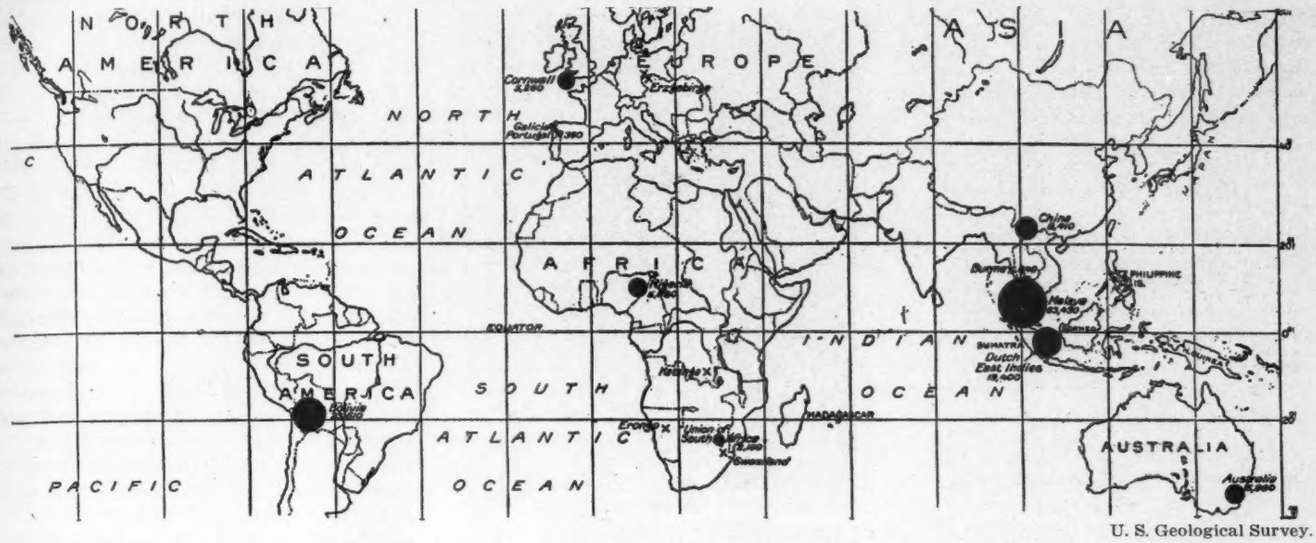
	Tons
Straits	37,535
Australian	1,440
Banka and Billiton	3,675
English	3,215
Chinese	4,490
Sundry	208

The stocks of tin held in the United States—the "visible" stocks—as reported by the New York Metal Exchange, averaged about 4,084 tons in 1920 and, according to *Steel and Metal Digest* were 2,551 tons on November 5, 1921. These figures give but a partial idea, however, of actual holdings by dealers and refiners which are generally credited to be from two to three times the "visible" stock at all times. The actual amount of tin in stock in this country in the latter part of December, 1921, was variously estimated at from 8,000 to 9,000 tons.

According to the statement of one authority in the United States the world's present holdings of tin are approximately; Straits Settlements 12,000 tons; Great Britain 7,000 tons; China 6,000 tons; Dutch 4,000 tons.

Tin Smelting

The Straits Settlements, with plants at Singapore and Penang, rank first among the nations as smelters of tin, the capacity being 58,000 tons. Much tin is smelted at these plants, however, besides that of Malayan origin, concentrates coming to them, at times, from China, Billiton, Siam, Nigeria and even



U. S. Geological Survey.

Map showing world's output of tin in 1916, in short tons. Districts producing less than 1,000 tons yearly are shown by crosses.

Alaska. The output of these smelters, therefore, does not always represent the product of Malayan mines, being generally larger.

Great Britain comes next in the list with five smelting plants of total capacity of 33,900 tons. Third in line is the United States with two plants of total capacity of 30,000 tons.

The total smelting capacity of the world is, according to *Mineral Industry*, 163,412 tons a year—an amount considerably above the annual tin output.

Tin Smelting in the United States

The two United States smelters were built primarily to treat Bolivian concentrates. The original ores average five or six per cent. tin and are concentrated at the mines to about 60 per cent. tin content or better, and then shipped in bags weighing 110 pounds each by steamer through the Panama Canal. They are consigned either to this country, to England or to Germany. When received in New York they are lightered to the smelting plant and are weighed and sampled by representatives of the buyer and the seller whose assays govern the settlement. Ores are mixed according to quality and results required and are put through lixiviation treatment for refinement. Ores are smelted at the plant of the Williams Harvey Corporation at Jamaica Bay in reverberatory furnaces and by-products treated in blast furnaces. Metal from the reverberatory furnaces goes through a liquating process for the final refinement and is run into pigs weighing about 90 pounds, ready for shipment. All fumes from the lixiviation and smelting plants are collected in a fume collection plant known as the Cottrell electric precipitation plant. Compressed air is used for tossing or agitating the metal with a small plant, 100 cubic feet per minute, at 30 pounds pressure. Water and fuel oil are also lifted with compressed air, the former at 100 pounds pressure, the latter at 40 pounds.

The tin refining department of the American Smelting and Refining Company at Perth Amboy is an important feature at that plant. Bolivian concentrates are there treated in a plant consisting of a blast furnace, a Dwight-Lloyd sintering machine, reverberatory furnaces, wedge roadsters, slag furnaces, crushers, etc. A bag house is used to collect the values contained in the fumes from furnaces and roadsters. After the ore is reduced to the proper concentration it is cast into anodes which are treated in an electrolytic refining plant similar to the electrolytic treatment of copper and lead. The slimes from the electrolytic tanks are treated for the values they contain.

The tin smelting industry in this country is a new venture and both plants now engaged in the operation are first-class, up-to-date in every respect and fully capable of meeting foreign competition. The opening of the Panama Canal was one of the reasons for undertaking it as this country was the largest consumer of tin in the world—consumption being in the neighborhood of 40,000 to 50,000 tons, running as high as 60,000 tons during the war, all tin previously used in this country coming from abroad. The influencing factors were low freight rates on concentrates from Bolivia and the fact that freight rates on pig tin from Europe were relatively high.

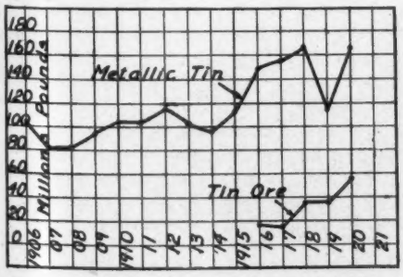
It was the contention, which has since been fully realized, that the United States would be able to smelt Bolivian concentrates into marketable tin more cheaply than European plants which would have the same rates on the concentrate to their plants plus the freight of the refined tin to this country. The mechanical success of smelting operations in this country is equal or better than anything ever undertaken. It remains only to test the possibility of continuing to operate in successful competition with cheaper labor of other lands. Heretofore all work of this character has been performed in countries where the standard of living is far below ours, but American smelters claim that, with the advantage in freights referred to and superiority in mechanical equipment, this handicap can, and is being overcome.

The immediate effect of the installation of smelters in America, which were put in operation in 1915 and 1916, is seen in the rapid rise in importation of Bolivian ores from 9,304 tons in 1916 to 28,895 tons in 1920.

Uses of Tin

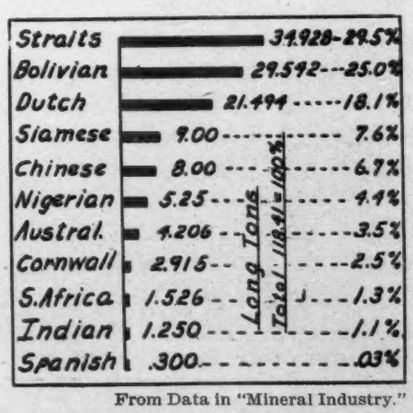
During the war the War Industries Board made a compilation of the uses of tin and of the amount of that metal consumed by the different industries in 1917. This compilation was the first information the trade had ever had of the disposition of its product.

Tin is used principally as a protective coating for other metals, and in the making of alloys, especially bearing metals and solders. A considerable quantity of pure tin oxide goes into white enamel. By increasing the proportions of lead, aluminum, zinc, antimony, copper, cadmium and bismuth in alloys of these metals with tin, the latter has been considera-



From Data in "Mineral Industry."

United States Tin Imports.



From Data in "Mineral Industry."

World tin production in 1920.

bly conserved. A complete substitute for tin is not known.

The following table was prepared from the compilation of the War Industries Board from returns on pig tin for the calendar year 1917:

USES OF TIN

(In Tons of 2,240 Pounds)

	Tons	P. C.
Tin and Terne Plate	27,600	36
Solder	17,000	21
Babbitt and other Bearing Metal	10,800	14
Brass and Bronze	4,800	6
Collapsible Tubes	2,100	3
Tin Foil	4,000	6
White Metal	1,750	2
Tinning and Retinning	1,900	3
Chemicals	1,700	2
Platedware and Britaniaware	1,000	2
Miscellaneous	3,607	5
Total	76,257	100

Secondary Tin

The reclamation of tin from tin plate clippings, old tin cans and from the alloys has grown to be a business of considerable magnitude. During and shortly after the war as high as 200,000 tons of scrap metal was detinned in a year, yielding an average of about 1.5 per cent. of metallic tin. Since that time the volume of business has greatly fallen off.

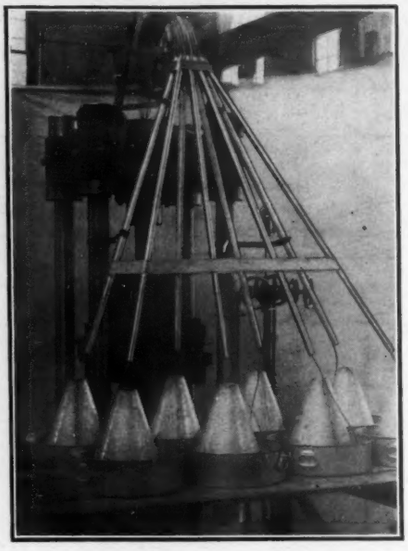
There are at least two large concerns in this country operating in detinning; the Vulcan Detinning Company with plants at Sewaren, N. J., Streeter, Ill., and Neville Island near Pittsburgh; the Metal Thermit Corporation, having plants at Chrome, N. J., East Chicago, Ind., and San Francisco.

In former times a large part of the business of these plants was the treatment of old tin cans. Since the armistice, however, this branch of the industry has declined greatly. Owing to low tin prices, high freight and labor costs it is claimed there is no longer a profit in that business. Tin is reclaimed both electrolytically and chemically and the product will often run as high as 99.80 to 99.95 pure, selling but a fraction of a cent below Straits tin.

In 1919 there was recovered from scrap, 5,977 short tons of secondary tin, and from alloys 18,056 tons.

The Prices of Tin

Tin is bought and sold in the New York market in cents per pound and in London in pounds per long ton according to the tin content and the reliability of the brand. Straits tin is the standard and constitutes by far the greatest bulk of tin traded in on the American market. In price it commands about a quarter of a cent a pound above any other grade even with as high or higher tin content. This is accounted for by the fact of its long established reliability. The tin content in pigs ranges anywhere from 99.00 to 99.960 pure.



Hydraulic extrusion press used in the manufacture of wire solder. This is a photograph of one of a number of hydraulic pressses used in the plant of Marks Lissberger & Son, Inc., Long Island City, New York, in producing extruded wire solder. This wire solder is made of Virgin Straits tin and Virgin lead mixed in any proportion desired and run in a variety of gages. Each machine has a capacity of 5,000 lbs. a day.

STRAITS PIG TIN PRICES IN NEW YORK

(In Cents Per Pound)

From "Metal Statistics."

	High	Low	Average
1910	28.28	32 74	34.27
1911	46.16	40.76	42.68
1912	50.11	42.86	46.43
1913	50.45	37.64	44.32
1914	50.60	30.40	35.70
1915	48.94	33.08	38.66
1916	51.75	38.46	43.48
1917	85.35	44.19	61.65
1918	110.00	71.50	86.80
1919	72.50	54.17	65.54
1920	62.89	34 15	50 36
1921	39.00	26.00	*33.00

*Average December 13, 1921.

The world is over-stocked with tin which has had, and still has, a depressing effect on prices. When the bottom dropped out of the market in 1920 it was necessary for the government of the Federated Malay States to take some action in order to protect one of its chief industries. Left to themselves the mine owners would close down because the price was under the cost of production. To avert panic—or perhaps worse— the government agreed to take a certain portion of the Malayan tin output at an agreed price. This had the effect of bolstering up the market for a time and keeping the miners at work. New tin, the world over, is now being produced in quantity practically sufficient to meet the demand of the depressed business condition that now exists. But the menace of the huge stock is still present. The government of the Federated Malay States would like to get rid of some of its 12,000 tons but dares not do so for fear of upsetting the market. Much the same may be said of the private owners of stocks of tin in various parts of the world who are loosening up only as it becomes absolutely necessary.

All owners of stocks, as well as all producers, are looking to America as their hope for the future and are clinging tenaciously to their stocks anticipating a better demand from this country. It is an over-stocked market that was responsible for the fact that tin is one of the few commodities that failed to respond in price in the general advance of 1919 and 1920. Reaching its peak during the war, in 1918, the price has gradually declined so that the past year (1921) has witnessed the lowest price since 1908.

There are no misgivings in the trade as to the future of tin. The industry is merely undergoing the same operation which has been the lot of so many others. Since no adequate substitute for the metal has ever been found it is merely a question of time before it will resume its former place in the market of the world's essentials. It is generally believed that, with the establishment in this country of two of the largest smelting plants in the world, America will assume a more leading role in the industry than heretofore. It is just possible, also, that the United States may be able to wrest from London its age-old prerogative of price-fixer of the metal.

At Gutenberg, N. J., a series of wells used by the residents for water supply recently went dry owing to the blasting of neighboring rocks to make way for a sewer.

United States Rubber Co.

Sumatran summer resorts. Bungalow colony of the United States Rubber Company on the island of Sumatra, 4,300 feet above sea-level. Other European mining companies maintain similar institutions where their employes may escape, for a time, the heat and humidity of the coast. The Island of Banka, with its tin mines is almost directly under the equator. Natives, Chinese and Tamil can stand the humid climate and feel no ill effects. Europeans and Americans, however, must have a respite once in a while, which is found in the mountain altitudes readily accessible in most of the tropical islands of the East.

The Successful Sinking of Two Great Caissons

The First of the Hudson River Vehicular Tunnel Caissons in Place—Will Serve as Starting Points in Tunnel Driving, Also as Part of Ventilating System

By ROBERT G. SKERRETT

THE PLANS for the Hudson River Vehicular Tunnel call for the construction of a number of large ventilating shafts, some of which will rise from below the river bed, just inside of the pierhead lines, and the rest of them will mount through the earth inland, not far from the bulkhead lines on the New York and New Jersey shores. Preliminary work to this end has recently been completed by the sinking of two big caissons at Spring and at Canal Streets in New York City.

Compressed air has played so helpful a part in the sinking of caissons upon so many occasions that the execution of tasks of this sort has become a comparative commonplace. In the present instances, however, the magnitude of the structures and certain local conditions have given to the sinking of these particular caissons elements of exceptional interest.

In addition to their becoming integral parts of the Vehicular Tunnel's ventilating system, the caissons are to serve as starting points for the driving of the shields that are to pierce the earth beneath the river and also to facilitate the excavations eastward and upward to the portals at street level. Under the circumstances, then, the emplacement of these caissons marks a material advance in the whole project so essential to promoting rapid vehicular intercommunication between the Metropolis and near-by New Jersey.

The sites where the two caissons have been sunk are a little more than 200 feet apart and at points close to West Street, upon which Spring and Canal Streets converge. Each caisson, fabricated of open-hearth steel, has a horizontal cross section measuring 47 feet by 42 feet four inches. The Spring Street structure is 53 feet seven inches from top to bottom while the Canal Street caisson is 60 feet high. The top of each caisson lies three feet below the pavement, and the structures rest well within a stratum of sand.

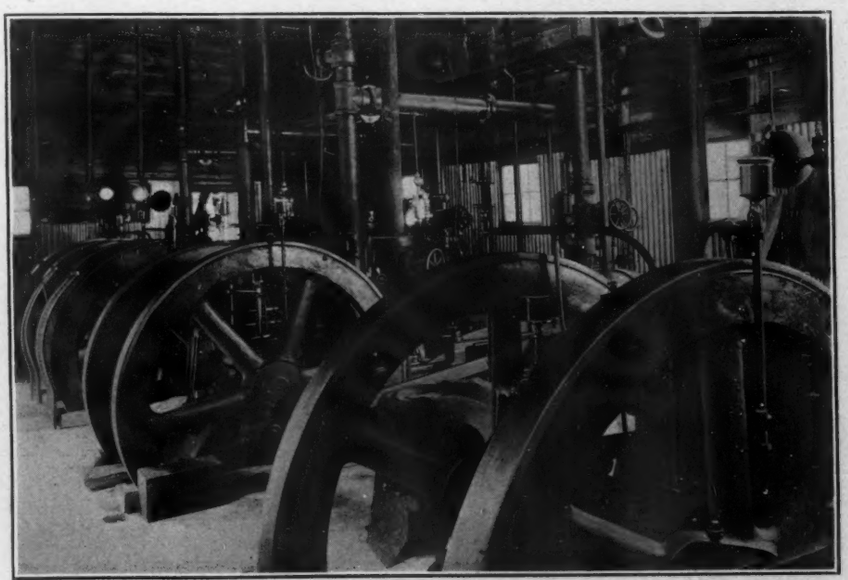
The sinking of the Spring Street caisson has involved the exercise of more than usual care because of its nearness to neighboring buildings—the distance being but twenty feet at the south side. The contract specified that the contractor should employ methods which would be most apt to insure safety and to preserve the stability of the adjacent foundations, walls, and other parts of the surrounding properties. This meant not only providing suitable underpinning but it implied recourse to a line of procedure which could be counted upon to minimize ground disturbances and thereby lessen any troublesome reactions. The engineering experts of the Commission collaborated effectively in achieving the latter end; and herein lies one of the most interesting phases of the work. But before discussing this angle of the subject let us get a fuller grasp of the preparatory aspects of the whole job.

As might be expected, the specifications required that the compressing plant should be capable of furnishing air sufficient in volume and pressure to enable the sinkings to be put through as nearly as practicable in the dry and to afford the while a circulation which would give a satisfactory ventilation. The installation was called upon to supply air at a pressure of 100 pounds; and to meet the demands the equipment was composed of four machines having a total output of 2,800 cubic feet of free air per minute. Two of the compressors were of 650-foot capacity each, while the others had an individual capacity of 750 feet. The latter were high-pressure machines susceptible of ready conversion into low-pressure apparatus. The plant was used successively in sinking first the Spring Street caisson and then the Canal Street structure. Cooling facilities were employed which made it possible to keep the temperature of the air sent into the caissons moderate at all times. The piping through which air was delivered to the caissons was of such size that there was no risk of an excessive drop in pressure at any stage during working operations; and the air mains, of which there were at least two to each caisson, were fitted with suitable clapper valves at the discharge ends.

Each caisson was equipped with two air-locks for the passage outward of materials when the structures were under compressed air, and in addition there was provided a horizontal steel air-lock, set between the muck-locks, amply commodious to accommodate simultaneously all of the men employed. This provision included the moment of change of shift when a fresh gang was undergoing compression preparatory to relieving the crew below in the working chamber. This precautionary measure marks a wise departure in the practices commonly pursued in caisson sinking.

Ordinarily, the muck-locks constitute the passageways by which the sand-hogs descend into the working chamber or return to the surface. From the very nature of the primary function performed by them, the muck-locks have to be of moderate dimensions, and they are not large enough to hold at any time but a part of a gang, especially if the caisson be of goodly size. Therefore, in the event of a rapid or sudden loss of air pressure in the working chamber, it is difficult, if not impossible, to get all of the men out before invading water floods the compartment. The bigger the caisson the graver the risk run in this respect—hence the insistence upon the supplementary safeguard in the shape of a T-head lock.

The T-head lock installed on each of the Vehicular Tunnel caissons was twenty feet long and elliptical in cross section—the vertical axis being 4½ feet with a lesser horizontal axis of three feet. A wooden bench flanked each side of the interior of the lock upon which the sand-hogs could sit while being subjected to compression or decompression. The T-head lock had its own hoist or shaft connecting it with the working chamber, thus making its service entirely independent of the two neighboring

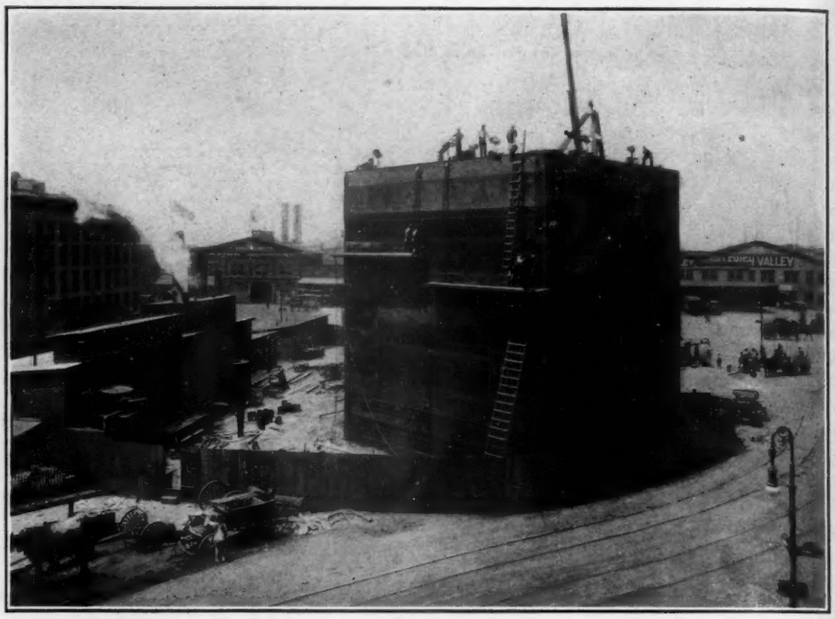


Canal Street shaft. Interior view of the compressor house showing the four compressors that supplied all the air used for the successive sinking of the two caissons.

muck-locks. A crew or shift numbered from twelve to fifteen. During the sinking of the caissons the T-head lock, even at the lowest limits, was in a position several feet above the level of mean high water; and when this auxiliary was not occupied it was kept open toward the working chamber, so as to be ready for instant use in case of an emergency. The lock was provided with a recording air gage and a clock. The dial of the gage was large enough to permit easy observation of the amount of rise and fall in air pressure. Another recording air gage, connected with the working chamber of each caisson was installed in the engineer's office. This gave the man in charge desirable information at all times. Sinking was carried on night and day save on Sundays and holidays.

The first step preliminary to the execution of the two jobs was to excavate rectangular pits ten feet deep and of slightly larger dimensions than the structures to be sunk. Then, in each of them, a caisson frame was erected and duly plated. When these double-walled monster steel boxes were finally riveted up and tested all was ready for recourse to compressed air and the downward journey. In passing, let us note that the working chambers measured from their sturdily reinforced ceilings to the lower limits of their cutting edges a matter of seven feet and embraced an area described by the external dimensions of the caissons.

The sinking of the Spring Street caisson was begun on June 27, 1920, and finished on the following 16th of July—the rate of descent averaging 2.69 feet a day. Work on the Canal Street caisson followed on the 29th of July, and was brought to conclusion when the structure reached the prescribed depth ten days later. The average rate of settlement was 4.84 feet per diem, and in the course of its sinking this caisson broke through the cribbing of an old dock. When that dock was built the shoreline was 250 feet farther to the east than at present, which illustrates how much filling in has since been done to form the land which now intervenes between this point and the existing waterfront. Notwithstanding the greater bulk of the Vehicular Tunnel caissons, they have been got into place at a speed that shows how the art has progressed.



The Canal Street caisson during the final stages of riveting. View showing caisson built complete before sinking. The space on the roof of the air chamber allows a sufficient weight of excavated dirt to be placed on the caisson to force it downward.

The rate of caisson sinking for the Fourteenth Street subway tunnel under the East River was from 1.47 feet to 1.76 feet daily. At Clark Street and at Montague Street, Brooklyn, caissons were carried down, respectively 2.94 feet and 2.17 feet per diem—the operations involving penetration through materials like those encountered in the Vehicular Tunnel jobs. The latter caissons necessitated in each case the excavation of 73.9 cubic yards of earth to effect a settlement of one foot, while the Clark Street caisson called for the removal of but 68 cubic yards for each foot of sinking. And now we come to perhaps the most significant aspect of the recent tasks.

A moment's thought makes it clear that the same compressed air which holds at bay the water so that the sand-hogs can do their digging in security naturally exerts a reflex impulse tending to sustain the superposed caisson—the measure of this moment depending upon the depth of the cutting edge, and the volume of the air. The farther down the caisson the greater the unit pressure per square inch required to counterbalance the hydrostatic head. Every pound of air applied within the working chamber of either of these caissons occasioned an uplifting effort equivalent to 143.5 tons. By the time the Spring Street caisson reached its resting place a maximum pressure of 22½ pounds was registered in the working chamber, whereas the pressure amounted to 27½ pounds in the Canal Street caisson when halted at its deeper level. That is to say, the Spring Street caisson had to hold its position in the end against a buoyant force of 3228.75 tons and the Canal Street caisson had to be kept down against an upward thrust totaling 3946.25 tons. Let us make it plain why it was imperative that the constantly changing uplift be duly neutralized at every stage in the sinking and especially when its magnitude approached the limits mentioned.

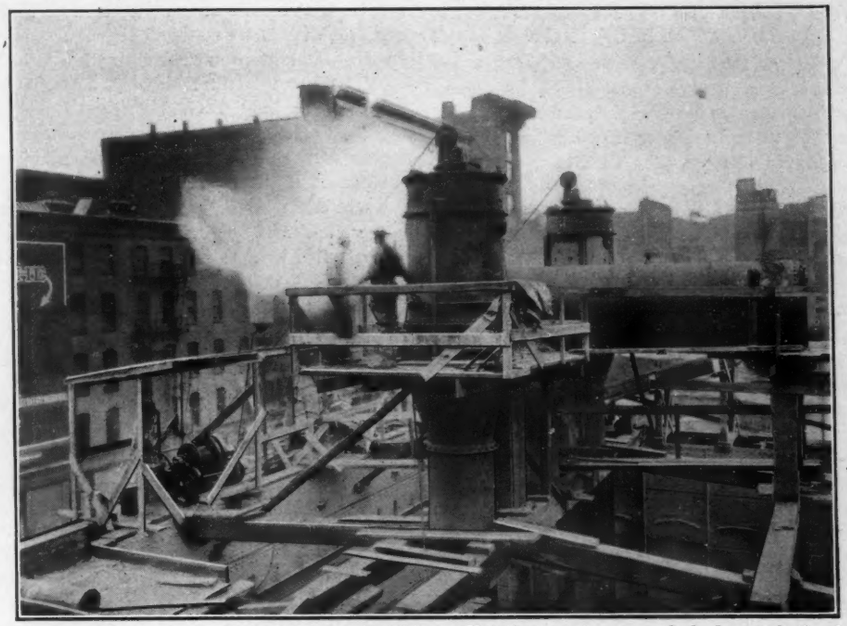
It should be evident that owing to the volume of air in either of the working chambers, once the roof of this compartment had arrived at

Canal Street caisson, showing excavated dirt on the roof of air chamber after the caisson had been sunk.

or descended below the ground-water level, it was essential that the impounded air should exclude a similar volume of water, approximating 14,000 cubic feet. What would happen if the penumatic pressure in the working chamber suddenly dropped so that the outlying water could rush in and fill the void? Naturally, this movement through the surrounding soil would tend to wash the earth with it; and, according to the measure of this displacement, the ground support of neighboring property would be proportionately affected by the undermining action. Imagine the damage consequent upon an occurrence of this sort!

To guard against such a contingency at any time during the sinking of the caissons, extra care was taken to see to it that these structures always bore down with an ample margin against the upward penumatic impulse. This end was achieved by resorting to the novel expedient of dumping muck upon the tops of the working chambers. Thus, as the caissons descended and the air pressure grew a compensating dead weight or increased burden was obtained through the accumulating spoils. As a result, the structures settled steadily and surely; and by reason of this unbroken movement any undermining tendency was held in check. Not only that, but this nice control of the subsidence of the caissons minimized the amount of underpinning and, to that extent, lessened the contractor's outlays.

Before the application of compressed air to the working chambers came to an end, the steel floors or inverts were put in place, thus sealing the structures across the bottom at the cutting edges. At the same time the metal work was thoroughly waterproofed. The need of these precautions was part of the preparation of the caissons as elements of the ventilating system. A further stage of this adaptation will consist in filling the spaces between the double steel skins or walls of the caissons with concrete. But this concreting on the east and the west sides of the structures will not be completed for a while, inasmuch as the pneumatic shields will be assembled in the great central compartments and be driven thence both riverward and inland toward the portals. In other words, the caissons will constitute subterranean bases of action for the actual excavation of the tunnel passages.



Spring Street caisson during course of sinking. Hoisting engines, muck locks, and the horizontal T-head lock are in plain view of the observer.

The rapidity with which the caissons have been sunk on the Manhattan side of the river is a fair indication of the celerity with which the engineers in charge will push forward the rest of the great undertaking, in which compressed air will play a still larger part before the subaqueous tubes link the New York and the New Jersey shores. The sinking of the caissons has been supervised on behalf of the Tunnel Commission by Engineer M. H. Freeman.

Spring Street caisson. View in working chamber showing raking timber in one corner to maintain the caisson in perpendicular position.

COMPRESSED AIR IN PITCHING MACHINE

An ingenious machine for pitching baseballs, which will throw any of the curves that man can throw and never a wild ball, is operated by compressed air. A compressor, sunk in the pitcher's box, supplies the air to a tank on the machine. It can be applied to the ball at any pressure, according to the speed desired. Sixty pounds have been found to give the speed of a ball pitched by the average man.

By means of a lever, the gun is "broken" in the middle, for loading. Other levers move the gun laterally and vertically for aiming. A trigger placed on the top releases the ball. This is accompanied by a sharp report. It is the inventor's practice, says "Popular Mechanics," to signal just before pressing the trigger, in order to give the batter the warning ordinarily by the pitcher's "wind-up," which precedes the throw.

The machine has a revolving turret, on one side of which is a hole for the passage of air. To accomplish a curve, air is applied to one side of the ball, causing the whirling motion which results in a curve. By revolving the turret, air may be applied to any side of the ball and any kind of a curve in a star pitcher's repertoire may be easily obtained.

WIDE ACTIVITY IN RAILWAY ELECTRIFICATION

DUE APPARENTLY to the marked increase in price of fuel which has taken place during the past few years, steam railroads all over the world are studying the possibilities of electrification as a means of lowering operating expenses.

Most of the leading countries in Europe have announced plans either to increase the present mileage of electrified steam railways or to carry out such work where hitherto electrification was not regarded as economically feasible. In South America, Brazil and Chile either have work under construction or are about to let contracts for such projects, according to Commerce Reports.

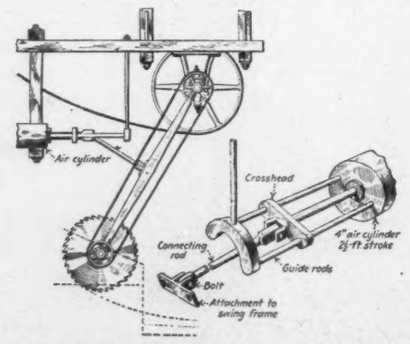
In Asia, Japan and India are both making investigations with a view to electrifying certain suburban or heavy-traffic sections. In Australia the suburban lines out of Melbourne have been in process of electrification for some years, and other projects in that country are under discussion. In Africa the question of electrifying steam railways of the Union of South Africa has reached the stage where bids have been invited and are in the hands of the consulting engineers, who are expected before long to place some part of the initial construction contract.

In the past, whenever the question of electrification has been taken up, the matter of increasing the capacity of a section of steam railway has probably been the greater factor, rather than reduction in operating expenses.

It is interesting to note that in many of the larger countries abroad the heavy trunk-line electrification projects in the United States have been very carefully studied and are very frequently referred to by foreign consulting engineers in their reports, and that in several instances standard American plans have been adopted practically complete by engineers advising foreign governments on steam railway electrification.

AIR PUSHES SWING SAW

THE swing saw is generally used in mine timber-framing shops. It has been standardized by different manufacturers, and, outside of refinements in bearings and hanger, does not admit of much improvement. In most of the swing saws on the market, provision is made for advancing the saw into its cut by means of a hand wheel operating a gear wheel which meshes with a rack attached to a short timber, one end of which is attached to the swinging frame. Handles are attached to the rim of the hand wheel to facilitate its use. At the Plymouth Consolidated Gold Mines, Ltd., Plymouth, Cal., Andrew Riley, master mechanic, discarded the arrangement just described and substituted in its place a compressed-air cylinder as shown in the figure, reports the *Engineering and Mining Journal*. The air cylinder is controlled by a valve placed in a convenient position. It is preferable both mechanically and from the consideration of safety.



The compressed air cylinder serves to advance the saw into its cut instead of the usual hand and gear wheel.

A HOMEMADE AIR GRADER FOR SEPARATOR

THE ACCOMPANYING sketch prepared by a correspondent of the *National Miller* shows the essential features of an apparatus devised for separating the various fine materials of a mill into different grades by means of a blast of air. As will be seen it may be used not only for grain ground and unground but also for sand, sawdust or any fine material.

A blower with a six inch delivery pipe was used and the connections were made with common black-iron stove pipe, a long sweep elbow being used. A sliding gate between the blower and the feed hopper and another gate between the hopper and the blower pipe permitted any desired rate of feed into a blast of air from zero to the full capacity of the blower.

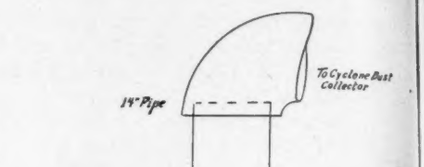
The six-inch pipe extended vertically a few inches into the lower end of a three-foot length of eight-inch pipe and an inclined spout was arranged to catch whatever material fell out of the air in the eight-inch vertical pipe. A similar length of ten-inch pipe was arranged, together with its spout, above the eight-inch pipe and a piece of twelve-inch pipe was put in a similar manner above the ten-inch pipe. A fourteen-inch elbow was placed above the twelve-inch pipe and the elbow was piped into a cyclone dust collector.

When material fell from the hopper into the blast of air from the blower, the material was all carried up the long sweep elbow until the vertical portion of the pipe was reached. From thence the heavy tailings fell down through the lower vertical pipe which was so arranged that no air escaped through it, an injector-like action causing some air to be drawn in instead of any being driven out with the tailings.

The remaining material was then driven by the blast up into the eight-inch vertical pipe where, the area being increased, the velocity of the blast diminished and was unable to carry up the larger or heavier particles. These particles fell down around the smaller pipe and were caught in the inclined spout and sent to a box or to a bin. Injectoraction also prevented air from coming out through the spout.

The same action took place at each of the larger pipes until only the very finest material was carried over through the dust collector. The diameters of the several vertical pipes may be varied according to the separations required.

It must be kept well in mind, however, that such a system works better with smaller pipes than with larger ones because were the first pipe twelve inches or more in diameter and served by a larger blower, the material in the middle of the twelve-inch stream would not be able to find its way out of the blast as quickly as from a six-inch column of air and material.



Showing the essential features of this apparatus for separating or grading fine materials.

From the above, it will be seen that the larger the units of this apparatus, the more the gradings will overlap each other, the more coarse material there would be in the finer grades and the more fine material caught with the coarser grades of stock. It would seem, therefore, that instead of being sent upward in a round vertical pipe, the discharge opening should be made flat and wide so that however great its capacity, the stream of material should never be more than three or four inches in thickness. This would permit the heavier pieces of material to very readily find their way out of the high into the low-pressure blast and would make the grade separations more sharply divided.

FOR A DEPARTMENT OF MINES

A BILL HAS been introduced by Senator Samuel D. Nicholson, of Colorado, to establish a Department of Mines, with a Secretary of Mines to have a seat in the Cabinet. The following bureaus are specified: Mining Technology, Mining and Applied Geology, Mineral Markets, Public Mineral Domain, Mineral Statistics, Publications, Accounting and Disbursing. The department would cover the coal, petroleum and gas industries, all metal mining and all non-metallic mining and quarrying, geological investigation, explosion and surveying, technical problems of mining ore and securing metal therefrom and problems of marketing raw metals or minerals, having nothing to do with manufactured or finished products.

50 per cent of the world's gold comes from the Transvaal.

The Birth and Development of the Rock Drill

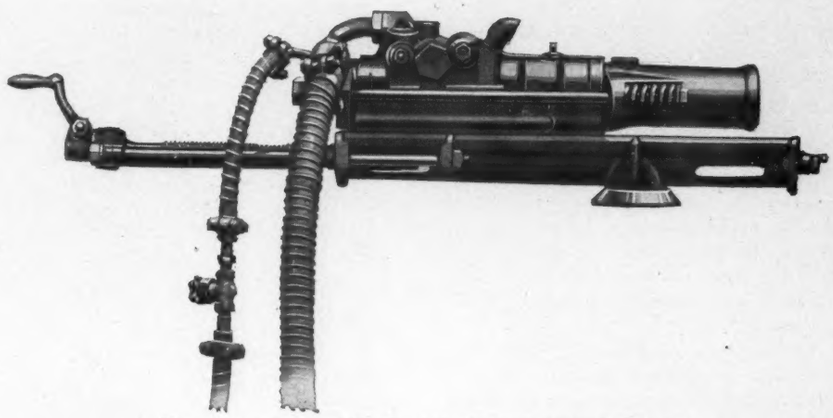
By W. L. SAUNDERS

THE ROCK DRILL is a development. It represents a gradual progress from hand drilling into various types of machines. The first borer was designed by J. M. and John A. Singer, one of them the inventor of the Singer sewing machine, who in 1838 experimented with a drop drill on the Illinois and Michigan Canal about 30 miles below Chicago. A dozen machines of the Singer type were used upon this canal. Later some of them were used at Lockport, during the enlargement of the Erie Canal. They were simply drop drills, restricted to vertical holes and striking the blow through gravity alone. Later on, hand operated rotary drills or augers, were used in the gypsum quarries in Paris.

In 1854 Mr. Nasmyth, a Britisher, the inventor of the steam hammer, proposed before the British Association for the Advancement of Science, a drill on the steam hammer principle. This drill was tried out in some gypsum quarries near Paris. Steam was used on one side of the piston only and there was no provision for rotating the drill.

The first European rock drill was patented in France in 1851 and was known as Cavé's rock drill. This drill was worked by compressed air. The cutting tool was rotated by hand by turning the handles. The drill was reversed by turning the valve by hand and was reciprocated by the direct action of steam or air with the cutting tool directly attached to the piston head. But as no motion was automatic the drill was slow of action and a failure from a practical point of view.

The first American percussion rock drill was invented by J. J. Couch, of Philadelphia, his patent being taken out in 1849. The Couch drill is considered to be the first practical percussion drill ever made. It consisted of a boiler mounted upon four wheels on the top of which was a wooden frame carrying the drill. The steel carrying the bit was thrown or disengaged from the frame, acting by momentum alone against the rock. There was an arrangement for rotating the drill by a ratchet wheel. While this drill was used only experimentally, it was the first instance of the use of a percussion type of rock drill, where the blow was struck independently of gravity and where the valve of the drilling engine worked automatically.

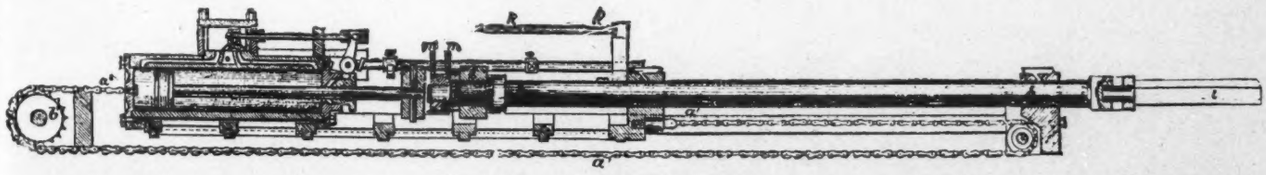


The most modern drill, No. 248 Leyner Ingersoll Drifter.

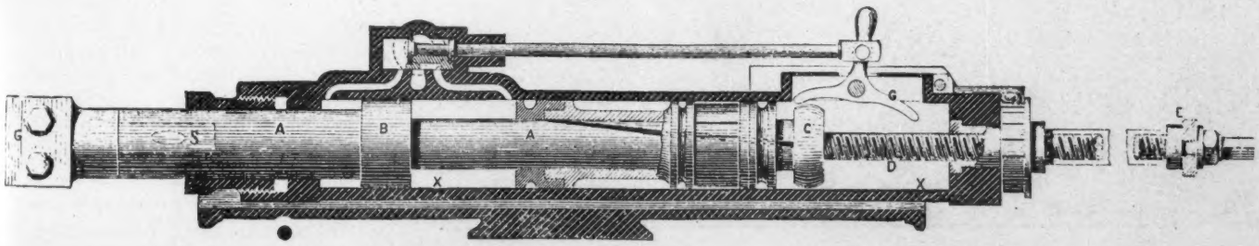
J. W. Fowle was assistant to Mr. Couch in the building of this drill. Fowle conceived the idea that the correct principle in rock drill construction was to impel the drill by the direct action of the steam or air on the piston and not by means of an auxiliary engine. He abandoned the Couch idea of throwing the drill steel like a lance. Fowle first took out a caveat in 1849, in which he described his drill as one in which the drilling tool is attached directly to the crosshead of the engine. He provided a ratchet and pawl method of rotating the wheel. This was the most important invention in the rock drill up to that time. The Fowle type of drill was adopted by the Italian and French Commission for the construction of the Mont Cenis Tunnel through the Alps.

In 1866, during the construction of the Hoosac Tunnel in Massachusetts, Brooks, Gates & Burleigh built a drill of the Couch type, modified by securing the tool to the piston, thus following the Fowle improvement. About forty of these machines were used in this tunnel. They weighed 240 pounds each and struck about 200 strokes per minute. They were found to be too expensive on account of breakages and were abandoned, being superseded by what became known as the Burleigh drill, which was used throughout the construction of the Hoosac Tunnel. This Burleigh drill, invented by Charles Burleigh, being an infringement of the Fowle patent, it became necessary to purchase this patent, which was done. Burleigh improved upon Fowle in the details of the machine. He dispensed with the crosshead and intermediate drill bar, attached the drill steel directly to the piston rod and rotated the cutting tool by rotating the piston. The Burleigh drill remained unchanged in its essentials until about '71 or '72.

All of the drills referred to in the foregoing were designed for mining purposes and were generally mounted on carriages. Simon Ingersoll was the first to develop the tripod form of mounting, using weights to hold the tripod down. Ingersoll's drill, constructed about 1871, was built fundamentally upon the Fowle-Burleigh patents, hence it became necessary to purchase these patents, which was done, after the completion of the Hoosac Tunnel, and the Ingersoll Rock Drill Company was organized.



Fowle's first rock drill. Caveat filed May 9, 1849.



The Burleigh drill.

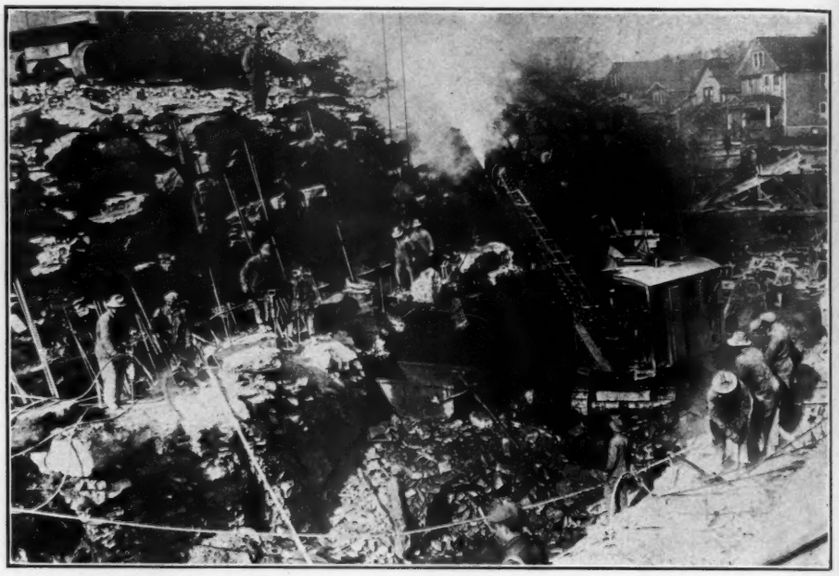
Scajaquada Creek, A Difficult Drilling Operation

By G. W. WINSLOW

SCAJAQUADA CREEK flowed through North Buffalo and carried a certain amount of drainage water which it eventually emptied into the Niagara River at Black Rock. It is now being deepened, widened and covered so that a modern drainage tunnel will function in place of the original creek bed.

In wet seasons the flood waters of the creek overflowed the banks so that each year resultant damage was done to property and also incidentally to private stock in nearby cellars. During dry seasons little water passed through the channel and again very unsanitary conditions prevailed.

It therefore became advisable to remedy these conditions, by providing a cover for the creek bed and enlarging the volume carrying capacity sufficiently to carry the excess water of the wet season. It was finally decided to make a cut and cover enlargement in the old creek bed and work on this was started in the fall of 1920. The plans called for a widening of the creek to approximately 45 ft. with a cut in the bed of from six to fourteen feet. The course of the creek was to be straightened out and short cuts made wherever feasible.



Trimming the sides of the creek bed by "channeling" with Jackhamers after the center of the bed has been deepened.

This excavation work made necessary the use of numerous rock drills preliminary to blasting out the rock encountered at many points along the channel course. Other compressed air machinery such as drill steel sharpeners and air compressors were vital factors in carrying on the project.

The first section of the creek upon which work was started in the fall extends from Main Street through Forest Lawn Cemetery to Delaware Park Lake, a total length of about one and one-half miles. Excavations on this section continued throughout the fall and winter of 1920 but at a slow rate. One 8x8 Type 14, portable air compressor was then used to operate from two to four drills, while a small electric compressor supplied air for a No. 50 drill steel sharpener. Later on additional air was purchased from a nearby plant, sufficient to operate three or four more drills.

In the spring of 1921, an 888 cu. ft. compressor was installed on the job and a second No. 50 sharpener put in operation. Several more Jackhamers were then put into continuous use one shift per day.

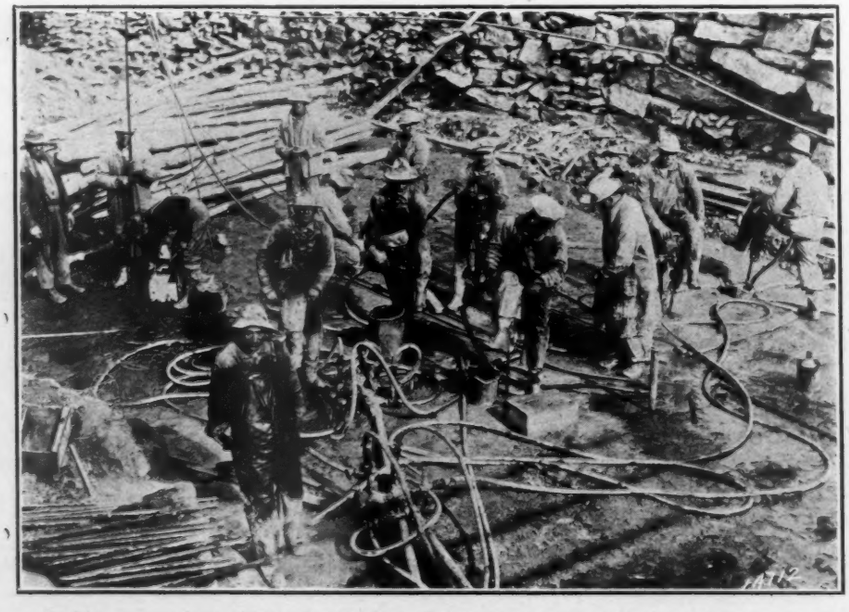
The nature of the rock removed made the drilling more difficult than would ordinarily be expected. It was a mean mixture of limestone and blue flint and was full of mud seams. Also some sticky lime with mostly wet holes, often ten to twelve feet deep and close together made it an unusual Jackhamer job.

The depth of the cut in the bed of the creek was, as stated, between six and fourteen feet. The center of the bed was first drilled and shot after which a steam shovel removed the rock fragments and dumped them into buckets. The filled buckets were then lifted by a crane and emptied on the muck piles. After the center of the bed had been cleared the two sides were "channeled" with Jackhamers, holes being drilled six inches to twelve inches apart. The shovel would then go back over a section and clean up.

During part of the construction, drilling was done under water and when the steel was down the drills would be operating almost entirely submerged. In the later stages of the work the water was mostly diverted and centrifugal pumps used to empty the remaining water into nearby storm sewers and gutters. The low water during the dry season made this procedure possible.

The progress of the work is well shown in the accompanying illustrations, which present various phases of the excavation and of the subsequent construction of the concrete tunnel lining. Blaw forms have been used throughout for forming the concrete. The concrete work is about 33 ft. x 16 ft. inside and 44 ft. x 22 ft. overall. The first section, one and one-half miles long was practically two-thirds completed several months ago.

The men in charge of the work are: Geo. H. Norton, City Engineer of Buffalo; John G. Ullman, engineer for the Buffalo Dredging Co., contractors; James Ganoon has charge of concrete work, James Stewart is rock superintendent while George J. Faber is superintendent of the job.



Jackhamers at work drilling in the channel bed preparatory to blasting out the rock.

Modern Drainage Tunnel Replaces Old Creek Bed

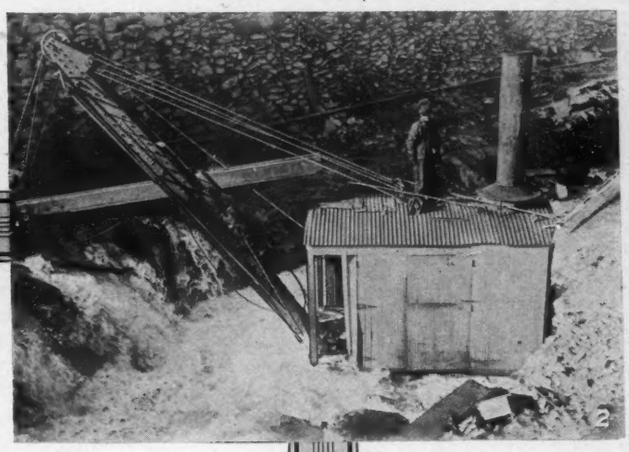


Fig. 1—Seamy rock, hard flint, sticky lime and holes ten to twelve feet deep made this a real rock drilling job. Fig. 2—Steam shovel operating in creek bed under high water conditions. Fig. 3—A view of the ditch showing the piles of rock fragments loosened with the aid of the rock drills. Fig. 4—A softer portion of the work where the shovels have made a yawning chasm of this peaceful street. Fig. 5—Steam shovel excavating its way under an old bridge. Fig. 6—A view of the final work showing the Blaw forms, the reinforcement and final concrete work.

FIGURING AIR FLOW IN PIPES FOR LARGE VOLUMES

By H. V. HAIGHT

IT IS PROPOSED to build a large central compressed air plant for a group of Canadian coal mines and in this connection I was asked for data on the flow of compressed air in pipes. The tables given in "Compressed Air Data," pages 76 and 77, go up to only 5,000 cubic feet of free air per minute and I was asked for figures covering from 5,000 to 20,000 cubic feet of free air per minute.

In the course of preparing this table I had occasion to compare several formulas for the friction loss and also had to develop some easy methods of making the calculations, both of which I think may be of interest to your readers.

The following formula developed by Mr. F. M. Towle of the Standard Oil Company. This formula has been derived after a great many observations on large natural gas and air transmission lines.

$$Q = C\sqrt{\frac{(P_1^2 - P_2^2)\,D^5}{L}}$$

Based on long pipe lines

C = 38.28 for air.

C = 50.0 for nat. gas. of .59 sp. gr.

C for any other gas is inversely in proportion to the square root of the specific gravity of the gas.

Q = Cu. ft. of free air or gas per hour.

P_1 = Init. Pres. lbs. per sq. in. absolute.

P_2 = Terminal pres. lbs. per sq. in. absolute.

D = Dia. of pipe in inches.

L = Length of pipe in miles.

Changing this formula so that

V = Cubic feet of free air or gas per minute.

L = Length of pipe in feet and using figure 38.28 for air, we have:

$$V = \frac{60}{5280} \times 38.28\sqrt{\frac{(P_1^2 - P_2^2)\,D^5}{L}}$$

$$= 46.5\sqrt{\frac{(P_1^2 - P_2^2)\,D^5}{L}}$$

Transposing gives:

$$P_1^2 - P_2^2 = \frac{V^2 L}{2150\ D^5}$$

COMPRESSED AIR of February, 1908, gives

$$P_1^2 - P_2^2 = \frac{V^2 L}{2000\ D^5}$$

which latter formula gives results about seven per cent. too high but is close enough for practical purposes.

The *American Machinist* of 1899, pages 686, 701 and 712 gives:

$$P_1^2 - P_2^2 = \frac{.0006\ V^2 L}{D^5}$$

This is about twenty per cent. higher still and is probably too high.

For any gas other than air insert S in this formula, where S = specific gravity of gas (air = 1) and the final formula becomes:

$$P_1^2 - P_2^2 = \frac{V^2 L S}{2000\ D^5}$$

To use this formula in calculating a table in the ordinary way would mean extracting a lot of square roots which involves a lot of work. To get the answer to three significant figures would mean finding the square root of a quantity having six significant figures. That is far too many figures for the slide rule or for the ordinary tables of square roots and it would have to be done by logarithms. Even the table of logarithms in pocketbooks usually go to only four or five significant figures and would require a good deal of interpolation.

It is possible, however, to do this work on a slide rule with results accurate to three significant figures and with a great saving in time.

Factoring $P_1^2 - P_2^2$ we get

$(P_1 - P_2)\ (P_1 + P_2)$.

$P_1 - P_2$ is the required friction loss.

$P_1 + P_2$ is approximately $2P_1$ or twice the given initial pressure.

In doing this on the slide rule the approximate loss is found by dividing by $2P_1$, and this first approximation is subtracted from $2P_1$ and the slide rule reset. If the pressure loss is very large a third approximation may be necessary. On the other hand, if the pressure loss is very small the first answer obtained by dividing by $2P_1$ will be close enough. This may sound a little long, but on the slide rule it is practically a continuous process and the answer can be read in a few seconds. Perhaps an example will make the process clearer.

Referring to the attached table, let us figure the friction loss for 12,000 cubic feet of free air per minute through 1,000 feet of eight inch pipe from an initial pressure of 80 pounds. For purposes of calculation the atmospheric pressure may be taken as fourteen pounds instead of 14.7 pounds. This would correspond to the actual atmospheric pressure at an altitude of about 1,200 feet above sea level. That is, we have:

$$(P_1 - P_2)\ (P_1 + P_2) = \frac{12000 \times 12000 \times 1000}{2000 \times 8 \times 8 \times 8 \times 8} = 2200$$

Now, $P_1 = 80 + 14 = 94$ lbs. absolute.

For a first approximation divide 2200 by twice 94 or 198, giving a pressure loss of 11.7 or 12 pounds. Subtracting 12 from 188 gives 176, which is the divisor for the second approximation. This gives a pressure loss of 12½ pounds, making the third divisor 175½ and the final answer 12.55.

Cu. Feet of Free Air Per Min.	Inside Diameter of Pipe in Inches						
	8"	10"	12"	14"	16"	18"	20"
5000	2.05	.67	.25	.12	.06		
6000	2.97	.96	.35	.18	.09		
7000	4.08	1.32	.48	.24	.13		
8000	5.34	1.72	.63	.32	.17	.09	
9000	6.75	2.18	.80	.40	.21	.12	
10000	8.55	2.70	.99	.50	.25	.14	.08
12000	12.55	3.91	1.43	.72	.37	.20	.12
14000		5.36	1.95	.98	.50	.28	.16
16000		7.08	2.56	1.28	.65	.36	.21
18000		9.05	3.24	1.61	.83	.46	.27
20000		11.30	4.02	2.00	1.02	.57	.34

Loss of pressure in pounds per square inch by friction in 1,000 foot length of pipe. Initial pressure 80 pounds gage.

HOW PETROLEUM IS MANIPULATED

Crude petroleum is used in decreasing quantities from year to year; more and more of it is prepared for higher utilization by breaking it up into refined products of greater value. The number of these refined products are many, and their uses are as various as the needs of mankind. The light-gravity ethereal products are employed as local anesthetics. The gasolines are the universal fuel of internal combustion engines. The naphthas are extensively used as solvents and are blended with raw casing-head gasoline to make commercial gasoline. The kerosenes, though used chiefly for illumination, are employed in increasing quantities as fuel for farm tractors. The lubricating oils and greases are indispensable to the operation of all kinds of machinery. The waxes derived from petroleum of paraffin base are utilized in many forms—as preservatives, as sources of illumination, and as constituents of surgical dressings made for the treatment of burns. Petroleum coke, an almost pure carbon, is used in metallurgy and in making battery carbons and arc-light pencils. Fuel oils obtained as by-products in refining petroleum are used for generating power by industrial plants, railroads and ocean steamers. Road oils are employed to lay the dust on streets and highways and artificial asphalt, a product of petroleum, has in some places been used for paving.

Investigations at the Pittsburgh Experiment Station on the technology of aluminum include studies of causes for and prevention of cracks in aluminum-alloy castings; disintegration of aluminum-manganese alloys; analysis of aluminum and aluminum alloys; the contraction and shrinkage of aluminum alloys; and the effect of remelting aluminum alloys.

Improving North American Sea Ports for World Trade

The Multiple and Diverse Uses of Compressed Air in All Kinds of Harbor Improvement Work Have Simplified Many Arduous if not Impossible Tasks

By EUGENE P. McCRORKEN

SHIPPING PROBLEMS and the influence of port facilities upon world commerce are becoming more apparent every day, especially in this present period of readjustment, while foreign trade development is still in a state of flux.

Plans are being proposed or are now in the course of execution in a number of our larger North American cities for harbor development for increasing the volume of business that can be handled.

Present harbor facilities are inadequate in many instances which causes a serious retarding of the natural growth of the industry of any locality.

New York, San Francisco, Montreal and Toronto all have port development problems confronting them, and in the normal course of events must take adequate measures to hold their places in the world's trade.

In all such plans for port improvements compressed air is the chief medium of power for accomplishing results. The pneumatic caisson for carrying down sea walls to bed rock and reclaiming areas of land from the sea is a tried and entirely successful method, and the costs of such construction work are subject to close approximation.

In addition, compressed air has proved a very useful adjunct in marine engineering work for such operations as reaming, chipping, riveting, drilling or in general wherever machine tools can be employed.

Perhaps a lack of proper appreciation of port and shipping problems may be justly charged against Americans as a whole, inasmuch as we are largely composed of "land lubbers" so to speak, who are not as sensitive to the needs of the situation as a more seafaring population would be. The port of New York is a striking example of this world wide shipping problem.

When, in 1609, just eleven years before the *Mayflower* landed at Plymouth Rock, Henry Hudson, that intrepid explorer in command of the *Half Moon,* set foot ashore on what is now Manhattan Island and sent his report to his backers, the Dutch East India Company, he observed therein that the newly found country was "rich in fur bearing animals, its soil the finest for cultivation, and the situation excellent for shipping."

It would seem that Hudson's vision was inspired and that he guessed better than he knew, since his verdict was destined for fulfillment in proportions exceeding anything he could possibly have conceived in the farthest reaches of his imagination.

ECONOMIC evolution of world trade has brought into prominence the necessity of providing adequate harbor accommodations for handling the huge bulk of commerce now being carried between ocean terminals.

Comprehensive plans are now under consideration by a number of American cities for harbor improvement and in this as in many other similar projects, the agency of compressed air and the pneumatic caisson is depended upon for the successful completion of these improvements.

Included in this proposed development work are plans to add a new manufacturing city to San Francisco, to make Montreal a great ocean port, and by the reclamation of part of the harbor to produce a really Greater New York.

Doubtless the commander of the *Half Moon* never realized that New York one day would have to be prepared to serve the wants of every industrial section of the country, whether it be the steel mills of Pittsburgh, the oil fields of the Southwest, as well as the automobile industry of Detroit or some other manufacturing center of the Great Middle West.

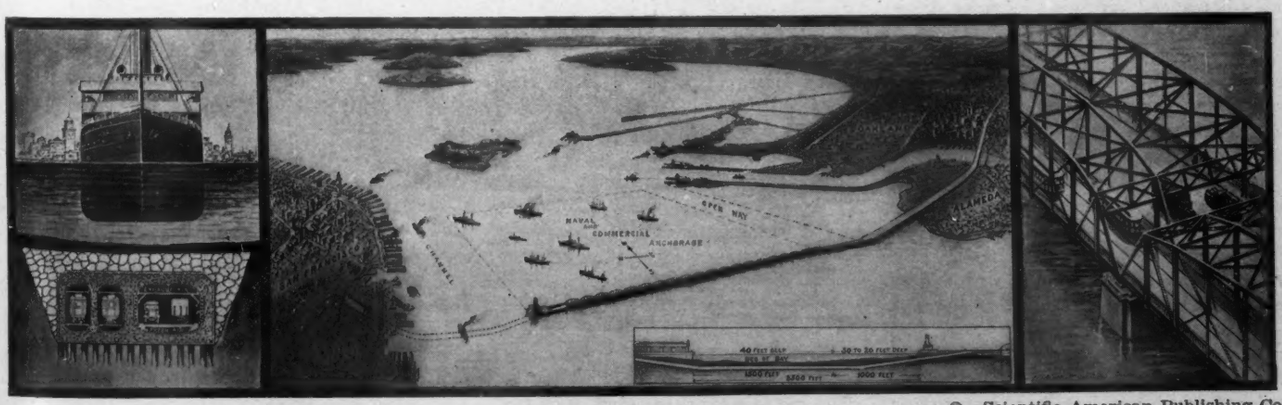
It is necessary to quote some figures in order to form a correct conception of New York's expansion and to gage its probable future growth in the next decade despite temporary business depressions or trade deflections.

The tonnage passing in and out of a port is the correct estimate of its capacity. In 1791 this tonnage amounted to 5,000 tons according to figures given by Thomas E. Rush, former surveyor of this port, in his comprehensive work "The Port of New York" and the year following it was 51,000 tons. Just prior to the Civil War it amounted to millions of tons, but for eleven years after 1880 it never reached the million mark until in 1905 it passed one and a half million, and in the recent war it reached and passed the two million mark.

In point of value, the imports coming through New York in 1860 were about $23,000,000; in 1880, $459,000,000, and in 1900, $537,000,000. During this period of four years, this port handled between 60 and 70 per cent. of the total of America's imports.

In 1910 the value of these imports assumed colossal proportions amounting to $936,000,000, which was 60 per cent of the total imports and just before the recent war in 1913 this value reached the huge sum of one billion dollars or 50 per cent of all the country's imports.

It is therefore easy to trace the steady consistent growth of this commercial gateway of the nation regardless of financial upheavals, trade fluctuations and tariff legislation which



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Left.—Cross-section of subway. Center.—Airplane view of San Francisco Bay between San Francisco and Oakland, showing the proposed railroad and highway crossing, which will include a 3,500-foot subway, 11,500 feet of bridge, 3,600 feet of pile trestle, and a 12,000-foot fill. Right.—Perspective detail view of the bridge portion of the crossing, showing the roadway, footwalk and two railway tracks.

occurred in the period just under consideration. New York, as the clearing house of the nation's business and as the home and source of livelihood of the 6,000,000 souls directing that business, will require the fullest development of all its natural advantages to discharge its duties properly. Just at the present time, although a readjustment in business is taking place, the volume of trade being handled is greater in New York than at any time prior to 1915, and less than one per cent. of office space in the financial district is vacant.

This brings us to the present moment where we must face the problem of handling the future commerce of this port in order that New York may attain its fullest development and that the industries of the country may not be hampered by insufficient harbor and railroad facilities. It should not be lost sight of that housing, feeding and otherwise ministering to the needs of the army of workers engaged in attending to this volume of commerce and expediting its movement are vital and inseparable phases of the problem. It is necessary to transfer millions of New York's population between their homes and business places every day and to provide them shelter, having proper light, heat, air and other sanitary surroundings.

Under the pressure of great and immediate demand on its existing facilities, New York has strained itself to the utmost to meet the needs of a growing population which experts estimate at 175,000 average increase yearly. We have been compelled to institute stringent traffic laws, zoning regulations, and to limit the height of buildings. This last regulation was intended to do away with streets that because of the unregulated height and bulk of buildings are dark canyons where sunlight never could reach the lower floors and their capacity for transportation was greatly overtaxed.

However good these improvements by legislation may be they are artificial to the purpose and only a temporary makeshift remedy which will not suffice in the next few years to come. New York City has at last reached its limit in building skyward and must now push out laterally.

Its business district must be located in the center of surrounding residential sections in order that the streams of humanity converging toward a more or less common center in the morning hours and diverging in many different directions in the evening after the close of business will have the shortest distance to travel and the means of transportation therefore will have the greatest capacity.

This unbalanced growth has thrown what engineers would say "the center of gravity of the mass outside the base" and consequently the natural arteries of traffic have become congested and the whole system is out of adjustment.

Mr. T. Kennard Thomson, a well known engineer distinguished for his achievements in municipal engineering fields, has put forward a simple solution. He would extend Manhattan Island from the sea wall at Battery Park six miles down New York bay, making the new Battery the same distance from Staten Island as the present Battery is from Jersey City, then carrying Broadway by tunnel to Staten Island, thereby tacking on six square miles or 167,770,000 square feet of reclaimed land to this densely populated elongated strip of *terra firma*.

This can be easily done from an engineering and financial standpoint by building sea walls from both sides of the battery carried down to bed rock, wherever the bed rock is not over 80 feet below the surface of the river. Then building sea walls to connect these two side walls would permit the pumping out of several square miles of enclosed area which would then be ready for the foundation of buildings and streets. All the lower end of the extension massive sea walls would be constructed and the intervening space filled up with sand. Dredges of 40 inches in diameter would be used in this work similar to those in use for years in Egypt where they have handled as much as 50,000 cubic yards per day.

The use of pneumatic caissons for sinking sea walls where any considerable depth is encountered will remove any possibility of blocking or obstructing the channel to which the Federal Government would have objections. Furthermore, this method would give an absolutely watertight wall which it is expected would remain intact.

The sinking of these sea walls will require about twelve miles of pneumatic caissons: Inside of the retaining walls there will be a concrete floor three feet in thickness. The sea walls will be from 25 to 30 feet in width and extend 30 to 90 feet in depth.

The depth of water at the sea wall at Battery Place is twenty feet. Throughout the construction of this project it is not expected to reach anywhere the pressures encountered in the building of some parts of the Croton dam. The practice of carrying on work of this kind at depths up to 80 feet is of common occurrence but at greater depth it becomes quite costly. One hundred and twelve feet is considered a maximum depth where the pressure amounts to about 50 pounds per square inch, and men are allowed to work only two shifts of 45 minutes each per day, which brings the cost of labor under the rates prescribed by the Sand Hogs Union to a very high figure.

However the cost of sinking foundations to such a depth is by no means prohibitive where necessary as the foundations of the Municipal Building facing City Hall Park were sunk to a depth of 143 feet below the sidewalk, 112 feet of which are below sea level, which foundations carry the 34 stories rising 539 feet into the air. The cost of placing this foundation was $1,500,000, the largest contract of the kind ever given in this country. This work now would cost three or four million dollars.

An illustration of the mobility of the soil of lower Manhattan at such depths is shown by an incident which occurred in the course of sinking this foundation. It may be considered to possess all the properties of a fluid. The pipe connecting with the air chamber at the bottom of the shaft for some reason went out of commission and while but fifteen minutes time was required to make all the repairs, this interval was sufficient for the mobile sand to completely fill the air chamber six feet in height above the cutting shoe and to travel sixteen feet up the pipe above the top of the chamber while the water rose in the shaft to a height of 40 feet. By good fortune the men, at the moment of the failure of the air pipe, were coming up the shaft and the last man was just able to keep in advance of the rising water as he hastily climbed the ladder.

The reclaiming of areas of land in lower Manhattan is not by any means a new or untried project. The proposed site of the new court house, now the center and head of the official life of New York, surrounded as it is by municipal and county buildings, including the afore mentioned Municipal Building on the east with 651,000 square feet of office space, and faced on the west by the Woolworth Building, the highest inhabited structure in the world with its tower rising to a height of 750 feet, was once occupied by a lake 60 feet deep. The pond covered 60 to 70 acres and was the sole source of water supply at one time on Manhattan Island. This pond drained partly through to the East River, but chiefly through a creek which followed the present course of Canal Street. It constituted the main drainage system of the surrounding section and is probably at the present time draining through the present big sewer underneath Canal Street.

It would also probably interest New Yorkers to know that Pearl Street was once the shore of Manhattan Island along the East River and it was so named because of the pearly character of the shells picked up along its course. Likewise, Greenwich Street was the shore line of the Hudson on the East so that these former boundary lines have now been extended or widened three blocks in each direction by reclaiming land covered by the East and Hudson Rivers. To the South also this reclamation has been resorted to as the present site of the Custom House was once covered by twenty feet of the water of New York harbor. Broad Street was once the location of a canal with a bridge for crossing it at a point now called Bridge Street.

So that this proposed six mile extension is merely a matter of history repeating itself or a continuation of a process of land reclamation inaugurated in early Knickerbocker days.

In regard to the feasibility of this scheme, Mr. Thomson has received opinions from experienced engineers and contractors. The following is from a letter received from an eminent contractor, Arthur McMullen:

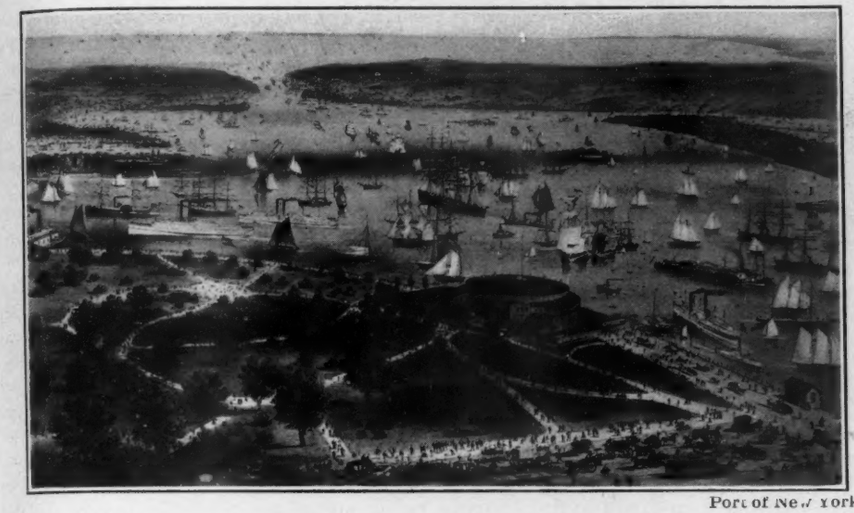
"In reference to your request for my opinion of the feasibility of your project for 'A Really Greater New York,' I would say that there are no engineering or constructional difficulties which could not be easily overcome. The magnitude of the work, the simplicity of the design and the location (which is not only convenient for work, but in the heart of the labor and money markets) would insure the lowest unit prices for the work.

"'The various parts of the construction would be eagerly sought after by all the best contractors in the country.'

"Another opinion was received from Franklin Remington, Chairman, Foundation Company:

"'There is no physical reason that I can

The Present and Proposed Future Developments of the Port of New York



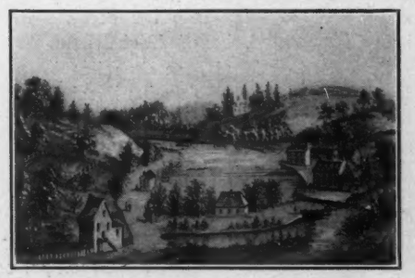
Port of New York.

Sailing ships in the port of New York from a bird's eye view from the Battery looking south. Entered according to Act of Congress in the year 1872 by Currier & Ives in the office of the librarian of Congress at Washington.

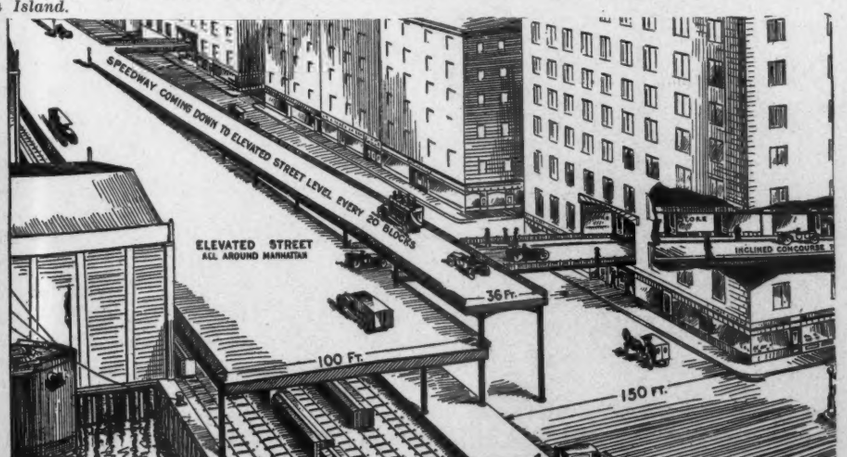
Wall and Pearl Streets, 1674.

Broad Street, canal and bridge, 1659.

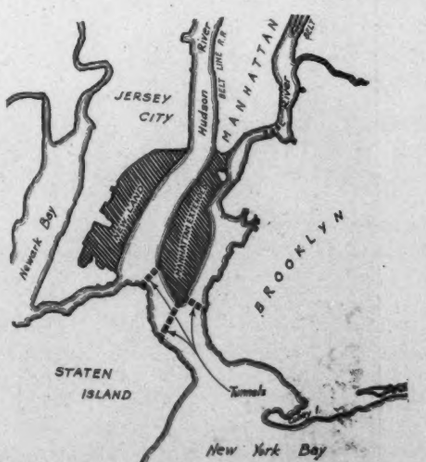
An aerial view of Battery Park, N. Y., and the surrounding downtown financial district, having the costliest real estate and piers in the world. From Battery Park, according to the Thomson plan, six square miles of land extending down New York Bay, would be added to Manhattan Island.



Collect Pond, 1776. This pond occupied the site for the proposed new courthouse, opposite the Hall of Records. It was 66 feet deep, covered 60 to 70 acres and was at one time the sole water supply on Manhattan Island.



Proposed six-track rail system with modern streets and docks which could be easily constructed in connection with the proposed six-mile extension to Manhattan Island.



Plan of proposed Manhattan six-mile extension put forward to solve New York's transportation problem.

A river steamer at New Orleans unloading cotton on dock.

see why this work cannot be done. I beg to say that we would have no hesitation in undertaking whatever part of this work was entrusted to us.'

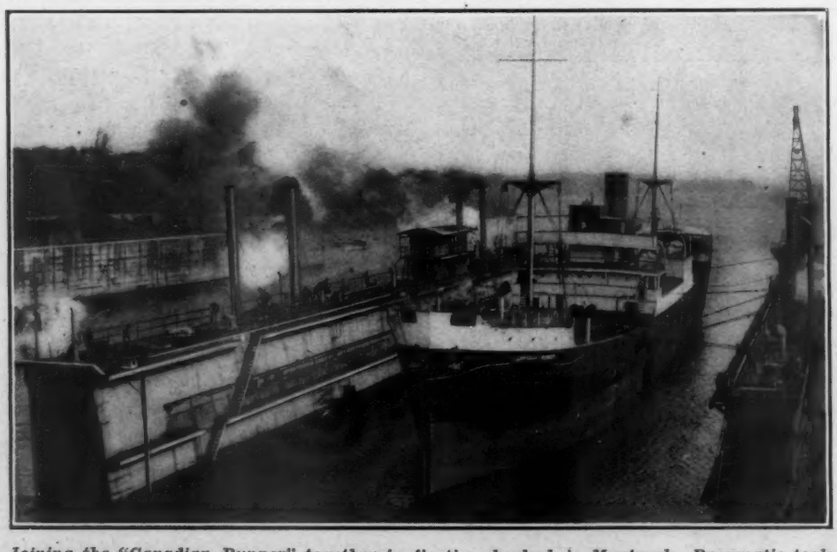
"Instead of it being a detriment or an obstruction to the so-called 'lordly Hudson,' our project will be actually advantageous for many reasons. To mention one only, we will have a massive concrete wall the whole length of our extension and we will dredge the channel as wide as the present Hudson for at least a depth of 45 to 50 feet, which will result in the Hudson River flowing directly to the Narrows, and then out into the ocean, without being interrupted, impeded, obstructed."

By extending Manhattan six miles down the Bay, we can also obtain twelve lineal miles for new docks. These docks will be arranged in such a manner that boats coming down the Hudson River will find their docks pointing up the Hudson. For those coming from the Sound, the pier slips will point towards the East River. Those from Jersey and Brooklyn will point towards Jersey and Brooklyn, and those for the ocean liners will point towards the Narrows, the object being, that the boats can enter their berths without the aid of tugs. The cost of these tugs must now amount to more than the steamship companies pay to the city for the use of such wharves.

Second, it is proposed to have tunnels from building line to building line to contain sewers, pipe lines, wires, etc., so it will never be necessary to dig up the streets to make these connections, but simply to open the cellar door to do so. Above this we will have the subway line, which will not be a dark hole in the ground, but have side-walks and stores' the whole length thereof on both sides, and will be as well lighted as our department stores. Above this there can be an opening two or three feet wide the whole length of the block, so the tunnels will have natural ventilation.

The ordinary street level would also have side-walks and stores as at present, and may have a third street level above, with an opening twenty or 30 feet wide down the centre of the block, which means, that buildings will have three valuable ground floors.

As a matter of fact, however, the benefits would not be confined to a 50 mile radius by any manner or means, for it would necessarily cheapen the handling of produce of everything passing through this port. It would enable shipping companies to reduce the charges, and would cut out railroad freight terminal charges, which now amount to more than the hauling charges all the way from Pittsburgh. As a matter of fact, every cotton field, wheat field, coal mine, and lumber industry in the United States would have to speed up to supply the increased demands brought about by this undertaking.



Joining the "Canadian Runner" together in floating drydock in Montreal. Pneumatic tools are used both to cut and assemble vessels which are moved in this manner.

San Francisco Needs Harbor Development

Similarly, San Francisco has also a port development problem as may be readily appreciated by a study of the accompanying map. Situated as it is high upon the rocks it is only seven miles "as the crow flies" from Oakland on the mainland. And yet to reach it by railroad requires a journey of 120 miles.

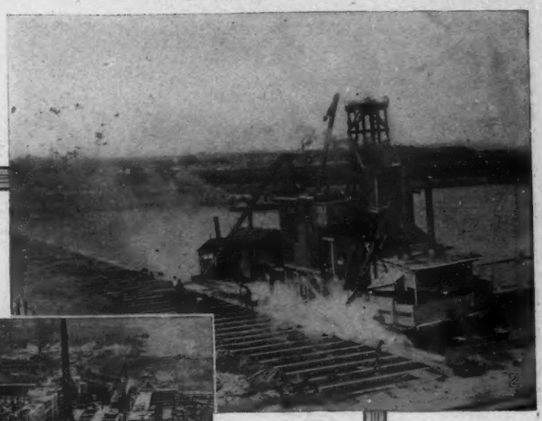
While the Golden Gate gives access to a harbor which has wonderful possibilities, it is as yet almost unused and inaccessible to the people of San Francisco if we consider the benefits which might be derived from such possibilities if they could only be made into realities.

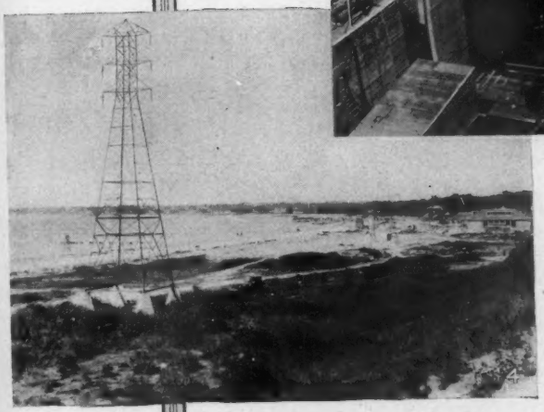
Again by the use of a sea wall constructed under the same general methods described in the proposed development of New York harbor, and according to the plans of Mr. Thomson a space of 35 square miles could be enclosed between Goat Island and Oakland and the connection completed by a subaqueous tunnel from San Francisco to Goat Island, a distance of two and a quarter miles, inasmuch as a free and unrestricted channel must be maintained between these two points.

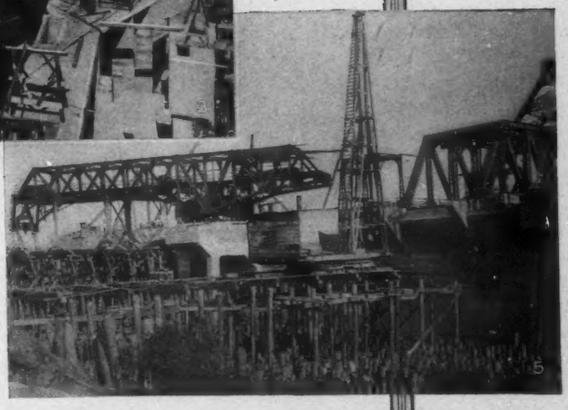
This undertaking would result in creating one of the really great terminals of the world and add an unexcelled manufacturing site on sea level thereby benefitting in the immediate vicinity San Francisco, Oakand and Berkeley and extending such advantages not alone over the entire State of California but the entire Pacific coast, the United States and Canada. Its direct beneficial influence would increase also the utility of the Panama Canal. It is also proposed to construct a great highway and railway from Oakland to San Francisco across the bay in order to relieve the congestion of automobile traffic which the present ferry boat service is at times entirely inadequate to take care of. The accompanying illustration is based upon the report of engineers engaged in the solution of this problem. Their recommendations include a subaqueous tunnel, 3500 feet in length, resting upon a foundation of piling or this tunnel could be constructed by the well known circular shield driven tunnel, the type adopted for the New York-New Jersey vehicular tunnel and used in the East River tunnels.

Canada, owing to the drain on merchant tonnage generally throughout the war, has made a notable effort to create a mercantile marine and to provide suitable harbor facilities. The first keel for a Canadian Government ship was laid at the yard of the Canadian Vickers, Ltd., Montreal, on June 11, 1918, and the first vessel was delivered on February 22, 1919. The programme of construction laid out at that

Various Stages of Harbor Development Work at Toronto, New York and New Orleans







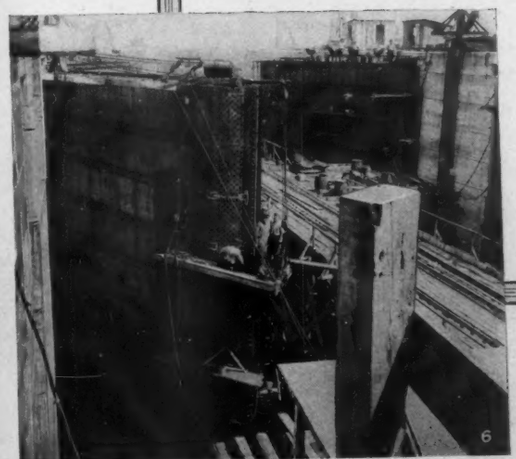


Fig. 1.—The ship canal wall under construction at Toronto. Concrete superstructure built on a pile foundation. Capping and pile appear in the picture. Fig 2.—Floating mixing plant pouring concrete into the sea-wall in front of the Canadian National Exhibition grounds. Fig. 3.—A section of the marvelous industrial canal at New Orleans, one of the biggest inland water schemes in America approaching completion. Fig. 4.—General view of reclaimed area for park and recreation purposes at Toronto. On the right is the Sunnyside pavilion, a high-class restaurant operated by the Harbor Commission of Toronto. Fig. 5.—Building one of the greatest locks of the New Orleans canal system. Fig. 6.—A close-up view looking down into one of the huge locks, just before the finishing touches are put on. An unusual photograph showing the painters already at work on the great iron framework. Fig. 7.—A large pier in course of construction at Weehawken, N. J., on the Jersey side of New York harbor. Thousands of piles from 60 to 70 feet long are being driven. Piers must support thousands of tons of freight, and also resist the bumpings of huge ships when they are docking.

© Ewing Galloway, N. Y.

A striking panorama of the great lumber docks at Baltimore. These piers are part of Baltimore harbor improvement scheme to provide increased facilities for import and export trade. These piers have been built by filling in between walls made by driving piles in the harbor bottom.

time included 63 vessels with a dead weight tonnage of about 325,000 tons. Three different types of construction were designed, namely: an 8,000-ton, a 5,000-ton, and a 3,500-ton type. The larger ships were allotted to the Canadian Vichers, Ltd., the Wallace Ship Yards, Ltd., and J. Coughlin & Sons, Ltd., of Vancouver. The Prince Rupert Dry Dock and Engineering Co. also were given a contract for two 8,000-ton ships, while some of the smaller ships were under construction on the Great Lakes at Port Arthur, Collingswood, Toronto, and Kingston.

For the year 1921, 961 ocean vessels have docked at Montreal as compared with 564 vessels in 1920. The almost 100 per cent. increase in ocean tonnage is the outstanding feature of the port's 1921 activity.

Toronto Improving Its Harbor

Toronto has undertaken the construction of one of the finest harbors on the Great Lakes. It is planned to construct piers, retaining walls, wharves, and breakwater covering an area of fifteen miles and the docks, fifteen in number, will cover a distance of two and one-half miles of the harbor. It is expected that this work commenced in 1912, but delayed by the war, will be completed in 1927 and in which 800 men have been in continuous employment. The work of reclamation alone will require 32,000,000 cubic yards of sand and will mean the enlargement of Toronto's industrial district as 1,200 acres will be reclaimed providing land for factory sites and 892 acres additional for parks and recreational purposes.

The harbor will have a navigable depth of 24 feet with provision for 30 feet to accommodate Atlantic liners.

Toronto's harbor improvement work has amply illustrated the utility of compressed air for all kinds of marine operations in general.

Compressed air was used in a multiple and indispensable number of operations both under and above the water in this harbor improvement scheme. The use of compressed air falls into two main divisions, one on the main land and adjoining ships and wharves; the other on scows in the harbor and operating independently of that on shore; on shore its chief use has been for drilling, boring, rivetting and hammering in the construction of the crib work forming the first foundation for the long concreted wharves, docks and sea walls. In the early part, the hand-worked auger and hand riveting was the only thing known to the foremen and workers in the making of these heavily timbered cribs, and to these men the results being achieved to-day with the pneumatically operated machines are almost incredible in the light of their earlier experiences with only hand tools.

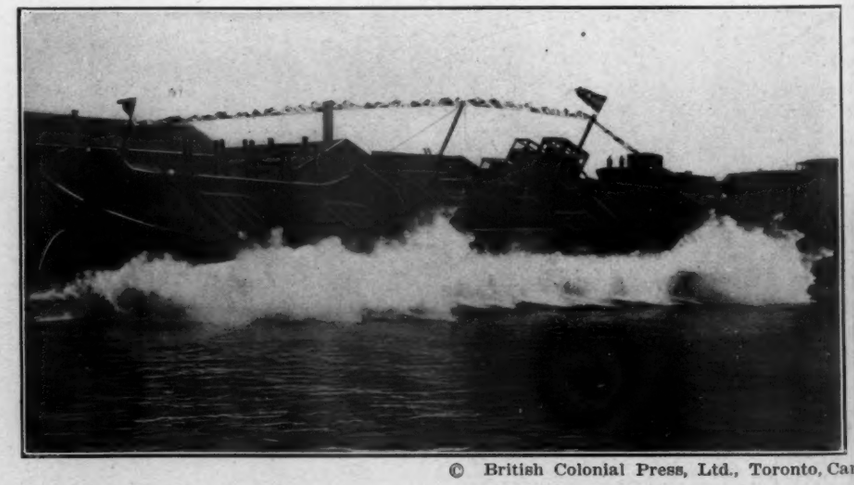
On the scows the compressed air supplies the divers, a considerable number of whom are engaged in various operations of harbor work. Fifteen pounds is sufficient for the living needs of the divers, but as on land, a minimum of 80 pounds is required for working purposes of the diver. These under-water workers commonly use air power for boring, rivetting, hammering, trimming and operations required in putting in floors on the cribs after the latter have been sunk to their required positions and before they receive the concrete blocks on top of which is finally laid the massed reinforced concrete which forms the new dock. Divers also use pneumatic drills and borers for placing piles around cribs, added as a precautionary measure for holding the same in place. The mechanical versatility of compressed air power was further demonstrated in connection with this work when a stubborn mass of concrete incorrectly laid out of place in the earlier part of the work was cut away with ease, whereas under the old method it would have been extremely laborious and tedious task and the occasion of much trouble all around.

It is the unanimous testimony of divers that compressed air loses none of its power or working utility under the water. These under-water workers are enthusiastic regarding its use and a good many of them now prefer a diver job to that of a surface man.

Montreal has many natural advantages which may yet make it one of the greatest sea ports of the world and one of the foremost industrial centers of this continent. As a sea port city, it has grown by leaps and in order to keep pace with this growth it must provide suitable facilities for shipping.

It has been proposed to reclaim about ten square miles of valuable real estate from what is now a bog. In connection therewith the development of a hydro electric power plant of 10,000,0000 horse power capacity has also been considered. These two additions, the power development along with the land reclamation project would create a manufacturing center unsurpassed in any part of the world.

In addition to the various harbors mentioned above where improvement work has been under consideration, there are numerous other ports which have either already started to provide increased facilities, prominent among which are New Orleans, Baltimore, and Buffalo. Some of these projects have been agitated for a long time but it may be said conservatively that harbor facilities will be an important economic factor in influencing trade routes in the near future.



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The launching of the 3,550-ton trans-Atlantic freighter S. S. "General Williams," at the yards of the Dominion Shipbuildnig Co., Toronto. She is 261 feet long with 43 feet beam.

Canal of Marseilles to the Rhone

The Canal Tunnel of the Rove 73 ft. Wide and 50 ft. High, Involving the Excavation of 3,000,000 cu. yd., Is One of the Largest Tunnels Ever Constructed

By H. VILLETARD
(Ingenieur des Arts & Manufactures)

THE PORT OF Marseilles which at the beginning of the 19th Century comprised only a natural dock, (the Old Port), has been developed towards the north by a series of artificial docks separated from the sea by a dam parallel to the coast. To the first four docks, the Joliette, Lazaret, Arenc and Gare Maritime, finished before 1870, the Bassin National was added in 1880, that of the Pinède in 1905 and now the Bassin du President Wilson which is about completed. Owing to the number of acres of the docks in service, also to the 24,000 yds. of quay development, the Port of Marseilles has been placed first among the Mediterranean ports, which has permitted it to handle the intense trade, especially during the war.

Notwithstanding this rapid development and the brilliant prosperity which ensued, the Port of Marseilles felt the necessity of getting connected with the important means of inland navigation, thus raising the question of connecting the Rhône to the harbor of Marseilles by a barge canal. This canal was to allow without any transhipment the traffic of barges of 1200 to 2000 tons.

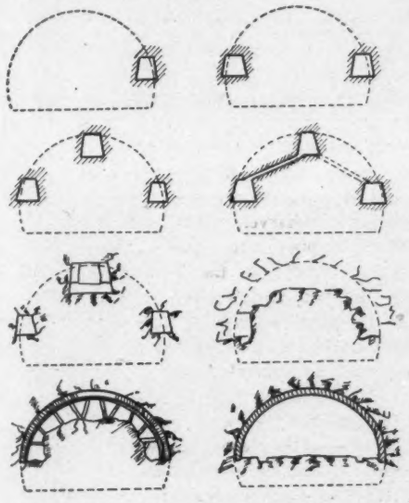
In the plan finally adopted the canal follows the sea-shore behind a breakwater parallel to the coast, up to the Bassin de la Lave, 2000 yds. farther than the village of L'Estaque. There it crosses the rocky hills of the Nerthe in the big tunnel of the Rove, which ends at the Etang de Bolmon by the Trench of Gignac. Following the southern bank of the Etang de Bolmon, the Canal enters the Etang de Berre, where, at Martigues it meets the Canal de Bouc to Martigues. It then crosses the Etang de Caronte, and at the end uses the old Canal from Arles to Bouc, the section of which has been increased accordingly.

The most important part of this work is the section from the sea up to the Etang de Berre, including the Trench of the Lave (115 yds. long), the Rove Tunnel (8000 yds. long), and the Trench of Gignac (nearly 2200 yds. long).

The total expense of these latter works will reach to more than 100,000,000 francs, in which the tunnel itself is figured for a value of about 80,000,000 francs.

The Rove Barge Canal

The final plan designed by Mr. Bourgougnan, chief engineer, and Mr. Aaron, civil engineer, was approved on July 4th, 1907, and was contracted—taking the prices in consideration, also methods used and time needed. Two sections were considered, i. e.:



Plan of driving pilot headings and method of widening out.

1—The southern half of the tunnel;

2—The northern half, plus the Trench of Gignac extending up to the Jai—which is a sand-dam separating the Etang de Bolmon from the Etang de Berre.

Mr. Leon Chagnaud, the specialist in big tunnel work, contracted this work.

The Rove Tunnel follows a south-north direction and is 73 ft. wide and 50 ft. high and about 8000 yds. long. The water-canal itself is 60 ft. wide, thirteen feet. deep and is bordered by two tow-paths seven feet wide, at a level five feet above sea-level. Every 300 ft. a sheltering nook is provided, thus enlarging the canal width and bigger chambers are arranged about every 1200 yds.

The dimensions of this tunnel render it the largest work of this kind ever achieved. Its section of over 3250 sq. ft. is about six times bigger than a double-track railway tunnel. The total volume of muck to dig out was equal to 3,000,000 cu. yds.

To give an idea of the magnitude of this work, we will say that the Loetschberg Tunnel, 16,000 yds. long, necessitated the excavation of 1,000,000 cu. yds. of muck; the St. Gothard, 16,400 yds. long, an excavation of 1,800,000 cu. yd. and lastly, two twin tunnels of the Simplon, each having a section of 435 sq. ft. and 21,500 yds. long represent a total amount of 2,100,000 cu. yds. excavated.

The Rove Tunnel is the longest that ever was driven entirely on French territory.

Method of Working

The start was made in April, 1911, by the sea-shore end.

Two galleries, each about 90 sq. ft. in section were driven at the base of the tunnel; the lower level of these galleries was at the level of the tow-paths, i. e.: five feet above sea-level. The gallery on the right-hand was driven first, the left one following it. These two galleries were connected by a series of short galleries at an angle of about 40 degrees with the central line of the tunnel, thus helping the ventilation of the tunnel and the hauling out of the cuttings.

From the top of these side galleries, inclined shafts were sunk every 60 ft., these shafts ending on each side of the top gallery (section 3). The top gallery (level 33 ft. above sea-level) as driven had a small area (40 sq. ft.) and the cuttings coming from this gallery were thrown with shovels in the side-paths, therefore facilitating the loading of the muck-cars in the lower gallery.

The top gallery was later on enlarged, (section 4) and its lower level excavated down to the level twenty feet above sea-level (section 5). At the end, the side excavations were achieved.

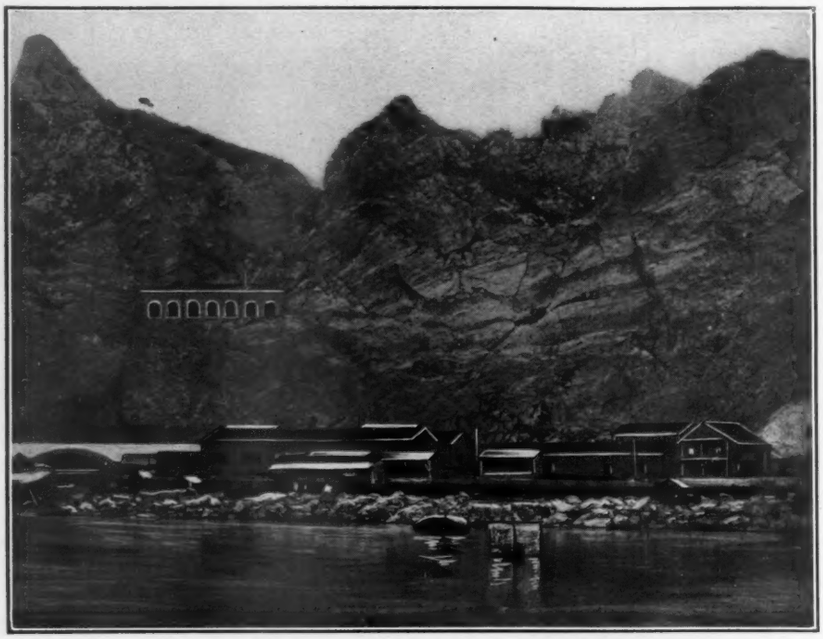
According to the nature of the ground, timber-work was used; in certain parts it being possible to make an excavation of 72 ft. in diameter without any support. In others, where the formation was softer (aptian marl) a very heavy wood-work was necessary, and the driving work had to be conducted with the greatest care.

The side-wall of the lower gallery from the floor level up to the height of about seven feet was made in advance in order to be ready to support the upper arch, which was built of steel forms of high resistance for holding the heavy stone-work.

The lining was made in 20 ft. sections. The

Showing timber arrangement in one of the small galleries.

Method of propping under the full size roof.



General view of the plant at the southern portal of the canal tunnel.

A view of the operations 1,300 feet from the southern portal.

Entrance to the underground workings as viewed from the interior.

arrangement giving the highest speed with the maximum of safety was as follows:

Every 60 ft., or every third section, one section was under work (driving, placing the forms or masonry, etc.). The next section was never worked before the complete setting and the taking off of the forms from the finished section. An exact idea of the progress of the work is given by the various sections of the tunnel shown in the accompanying illustrations, these sections being about 170 ft. apart. The driving work, or masonry, was made at the same time on three sections. This gives a total length of 1700 to 2000 ft. of tunnel under work.

Drilling, Ventilation, Illumination

The drilling work has been done exclusively with Ingersoll-Rand Jackhamers. Compressed air, at a pressure of 150 lbs. was furnished from the compressor-plants at each side of the tunnel, by seven-inch pipe leading up to and immediately behind the heading.

This system of drilling made possible a rate of advance of five to six feet per eight hours shift. It was useless to hurry the driving of the first galleries as was the custom in other tunnels, as the enormous amount of muck to be taken out of the tunnel was limiting the daily advance about fourteen feet of finished tunnel.

The ventilation was obtained by means of a 22-inch vent-pipe laid in the right-hand gallery, and in which powerful fans were blowing the fresh air wanted.

In 1913, when the Logis Neuf shaft was met, another fan was put on top of the shaft (500 ft. deep); this fan was blowing 17 cu. yds. per second, corresponding to 2.6 cu. yds. per man per minute, and 125 cu. yds. per lb. of dynamite exploded. Supplementary ventilation was provided by the exhaust air from the working of the pneumatic tools and the locomotives.

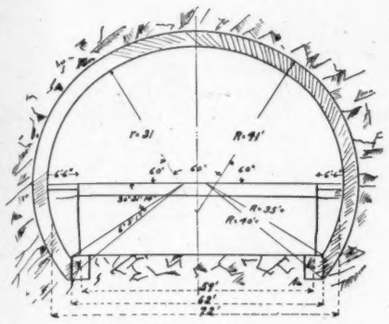
The illumination of the work was obtained by individual portable carbide lamps; the cranes fitted with electric lights and the locomotives with acetylene search-lights. When the stross is entirely taken off, the track is illuminated by 200-candle electric bulbs, and the station by powerful lamps.

Haulage and Disposal of Muck

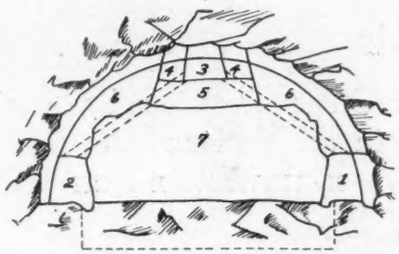
The muck is at the present time being hauled outside the tunnel on a 30-inch track by mechanical haulage. The type of muck-cars in use has been designed by the contractors. These cars have a capacity of four cubic yards, are mounted on a heavy frame, and are of the dumping type

At the heading, the muck is shoveled on a low platform car, and later on loaded in the dump-cars. The debris of the top gallery and of the sides falls by the action of gravity through vertical shafts leading to the top of the lower galleries. The muck shoveled by hand is received there in the cars which were pushed under the shaft in a convenient position.

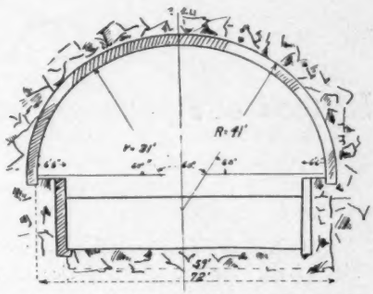
Behind, in the stross, the loading is made partly by hand and the remainder by compressed air cranes. The cars are hauled by means of compressed air locomotives. These locomotives of 150 to 200 h.p., have been designed for passing in the smaller sections of the galleries, and their weight is sufficient for hauling 200 ton trains. They are of two types:



The heavier type of tunnel construction.



Underground excavation plan.



Cross section of tunnel showing the light construction lining.

one of the H. K. Porter Co., Pittsburg, the other one built in France and designed by Mr. Chagnaud. These locomotives are both of the compound type and haul generally trains of 35 to 40 loaded cars.

Compressed air, under a pressure of 1400 lbs. for loading the locomotive tanks, is carried along the tunnel by a special pipe and provided with a loading station every 550 yds.

An important clearing station has been reserved at each entry of the tunnel, and the main track entering the tunnel follows the left-hand gallery. From time to time, the main track is connected to the right-hand gallery by side tracks for helping the traffic.

At about 4500 yds. from the entry, a station has been installed at 3/1000 slope alongside the stross. This track leads to the point +26 ft. and is used for supplying the lumber and the stross for masonry work. These materials are passed downwards for the main part of the lining, and elevated by the men for the upper part and the quay work.

At each entry, the muck trains are hauled away by compressed air locomotives of about 250 h.p.

The compact limestone is brought to a crushing plant, which furnishes all the broken stone and the crushed sand used for the masonry work. The remainder of the muck has been used for the dams, for filling the space behind the quay walls and for the new "President Wilson Dock" at the south. At the north entry near the Etang de Bolmon, it was used for building up industrial land along the lake.

With average conditions of work, the amount of muck hauled outside the tunnel, reached, for both entries, 1350 cu. yds. per day.

The formation encountered was mainly of compact limestone or marl and clay limestone. In many points, this limestone let water flow in the tunnel; several springs have also been found, having an output reaching 525 cu. yds. per hour in the dry season, and in winter 2700 cu. yds. per hour.

It has been very difficult to drain this amount of water on a horizontal distance of 9000 yds. Steel or concrete drain pipes have been used, and several pumping stations inside the tunnel were found necessary for pumping water from one station to the other. At the Ste. Maxime shaft a multi-cellular centrifugal pump had to be installed, raising water 230 ft. high. The total power required by the pumps reached some times 400 h.p. In 1913 a big crack in the limestone formation let over 800 cu. yds. of water flow in the tunnel. A considerable amount of grouting work was necessary for filling this crack.

The type of lining varies according to the nature of the formation met and the design of the side-paths.

In solid formations, the lining has a thickness of 28 in. to 40 in. The side walls are laid on the natural ground. The bottom of the canal will receive a lining of 24 in. thick. In the marl limestone, more or less brittle, the lining reaches a thickness of 40 in. to 50 in. The side walls are in this case supported by an important foundation four feet thick.

The thickness of the lining is equal from the sides to the quay.

The arch is built in 20 ft. sections without any connection with the next section. The masonry work is made with hard limestone blocks coming from big quarries which were opened by the contractors at Cassis and Marignane.

The sand was crushed, as we have seen, from the muck coming from the tunnel, and the mortar was made of an excellent quality of hydraulic lime.

Behind the stross the digging of the canal was started. The muck was loaded by hand into buckets, which were elevated by electric cranes and unloaded into dump-cars at the level +5 ft. Every 550 yds., a down slope of 3/1000 permits the placing of a track running down to the level—14 ft. Thus the muck coming from the lower part of the cut is quickly hauled to the upper level.

The motive power was supplied by the Compagnie d'Electricité de Marseille; for the south entry three phase current, 5000 volts, 50 cycles being available.

The compressing plant included three four-stage air compressors, working at a pressure of 1400 lbs. for the haulage plant, and three compound air compressors at 150 lbs. needed for the drilling. These compressors were actuated by 500 volt motors of more than 2000 total horse power. Several of these compressors of 500 h. p. were supplied by the Ingersoll-Rand Co.

The high voltage current was reduced in the tunnel by transforming stations every 1100 yds. A primary voltage of 5000 volts was reduced to 190/110 volts for the cranes, pumps and electric lights.

A locomotive repair shop, forge shop, etc., where more than 250 workmen were employed completed the working equipment.

Big lime stores were arranged which could hold a capacity sufficient for three months work.

A similar plant layout was provided at the north entry at Marignane, where the electric current was delivered at 1300 volts by the Energie Electrique du Littoral Mediterranean, and reduced to 440 volts, 25 cycles.

During the war, 1914-18, the work had been progressing, but at a reduced rate, owing to the lack of help and of raw material.

The headings came together on February 18th, 1916, thus helping the natural ventilation of the tunnel and facilitating the management by the direct communication between the two ends.

Since the end of the war, the number of men reached a total of 1200, working in three eight-hour shifts.

The air compressor plant at L'Estaque.

The Air Brush and Its Uses

A Method of Applying Paint or Other Materials by Low Pressure Air That Has Many Uses in the Various Industries

By HOWARD BEACH
Eclipse Air Brush Co.

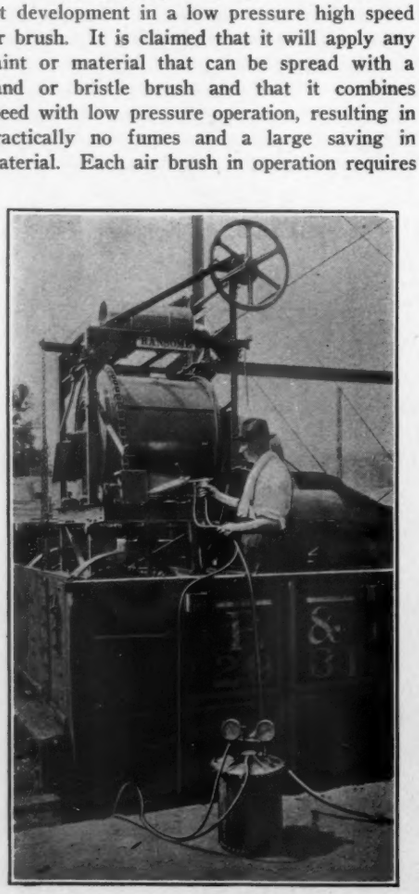
FEW PEOPLE are familiar with the possibilities of the "air brush" (a device which performs very nearly the same function as the hair paint brush), and still fewer know the difference between an air brush and a sprayer. The many uses of hair paint brushes are fairly well known and the sprayer or high pressure atomizer needs little introduction.

Many readers of this article, most likely, have used or have seen sprayers used for painting work in general, for lacquering, varnishing, enameling, japanning, etc.

The sprayer is constructed either on the syphon or gravity feed principle, there being no regulation of the spraying pressure or of the flow of material necessary to govern the speed of the operation. It is generally conceded good practice where sprayers are used to thin materials to a so-called spraying consistency (usually about fifteen per cent. to 25 per cent. below hand-brushing consistency,) and on varnishes, enamels and similar materials, to heat the material as well as the air or spraying pressure.

The accompanying illustrations show the latest development in a low pressure high speed air brush. It is claimed that it will apply any paint or material that can be spread with a hand or bristle brush and that it combines speed with low pressure operation, resulting in practically no fumes and a large saving in material. Each air brush in operation requires approximately three cubic feet of air per minute at pressures which vary, depending upon the density or viscosity of the material. For example, priming and undercoaters used for maintenance painting require from fifteen to eighteen pounds of pressure, while gloss paints, enamels, varnishes, etc., take from 22 to 25 pounds of pressure to apply perfectly.

Brightening up the walls and ceilings of a manufacturing plant with paint applied by the air brush.



Painting a completely assembled machine after loading on freight car for shipment.

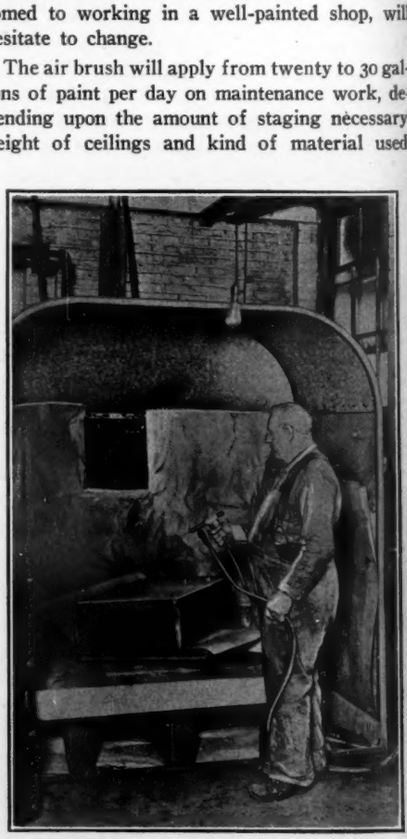
The air brush is simple to operate, very easy to clean and keep in service and it is not necessary to disconnect the gun from the hose in order to clean the unit. The builders of the low pressure air brush worked on the theory that painters, decorators and the class of labor using the air brush are not mechanics, and for a device of this kind to be successful, it must be as nearly both fool- and trouble-proof as it is possible to make it.

The air brush has an air-tight paint container, and regulated pressure forces the fluid (on the air displacement principle) up to the gun, where it comes in contact with only sufficient atomizing pressure to split up and lay the coating on the surface. Because of the low pressure, materials do not have to be specially thinned and heating of the air and material is not necessary, providing the material is suitable for bristle brushing and the work carried on where temperatures are favorable for the work.

Materials applied with the low pressure air brush dry fast and hard, due to the solvents and driers being left in the coating to oxidize and function normally, thus promoting the adherent, elastic and durable characteristics of the coating.

Another illustration shows the air brush applying mill white on plant maintenance painting. Flat coats, egg shell mill whites, etc., require from fifteen to eighteen pounds of pressure while gloss whites take from 22 to 25 pounds of pressure. Notable is the absence of fumes, due to low pressure. Many large machine shops, bakeries, warehouses, textile mills, leather plants, shoe factories, etc., are using the air brush to brighten up their plants. On this class of work, one coat with the air brush equals two coats with the hand brush. The first coat when hand-brushed will wipe the dust and dirt on the surface up into the coating, making the second coat necessary for first-class work. The many advantages of keeping a plant well painted should be of vital interest to everybody concerned, as it shows up very noticeably in the profit and loss statement. For example: hygiene and sanitation conditions are improved; the appearance of the working force improves with the general clean-up idea; better work; fewer seconds are lost because lighting is more effective; labor turnover is reduced because labor, once accustomed to working in a well-painted shop, will hesitate to change.

The air brush will apply from twenty to 30 gallons of paint per day on maintenance work, depending upon the amount of staging necessary, height of ceilings and kind of material used.



Twelve to sixteen dozen trunks a day are varnished by one operator with the installation shown.

The air brush room in a doll factory, where sixteen machines are in use applying enamel to the dolls.

More of this class of painting will be done and a better grade of paint used if an inexpensive, efficient and practical method of application is on the job.

A third illustration shows the air brush painting structural steel sections. Red leads, graphite, asphaltum, and red oxide paints to protect these products, are readily air brushed at pressures ranging from eighteen to 22 pounds of pressure. An even, smooth coating is applied to all riveted surfaces, as well as plain, flat surfaces, and the work is processed quickly at a fraction of the hand-brushed cost. Large gasholders, oil tanks, large boilers, etc., are fit subjects for the low pressure air brush. This class of work will be taken care of at more regular intervals if the cost of application is reduced to a point that is not prohibitive.

The air brush applying a protective coating to road building machinery is shown in another illustration. In this instance, this concern, before installing the air brush method, painted the parts of the product before it was assembled. Practically every corner of this large plant harbored an open pot of paint and brush. It was suggested that they should "paint them on the freight car just before they leave." The saving was great, the equipment reached its destination without the marks of assembling tools and a substantial decrease in the fire-insurance rate was made possible by removing the painting from the plant.

For coating the inside and outside of automobile battery boxes with an acid-resisting compound the air brush proves very satisfactory. The speed of the operation is three boxes per minute, which compares very favorably with a dipping process and the open dip tank hazard is eliminated.

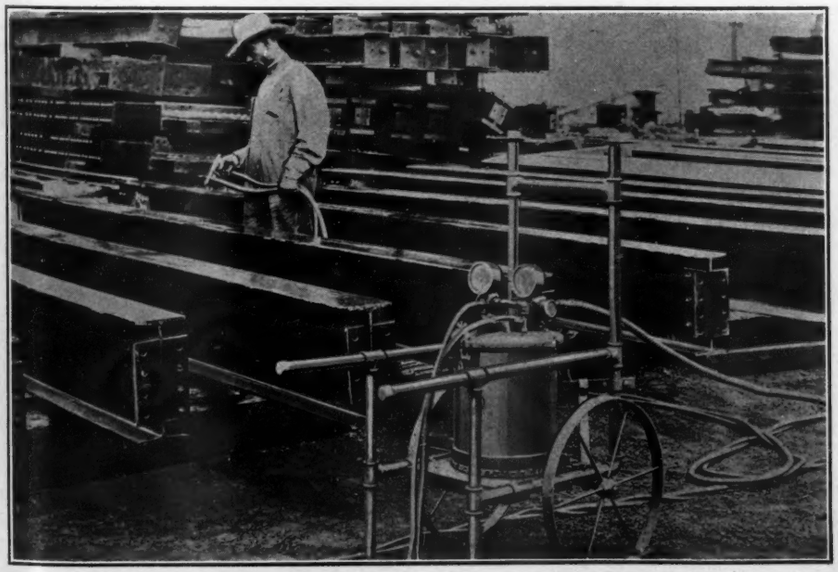
The air brush is also shown in use varnishing wardrobe trunks in a modern plant. A speed of from twelve to sixteen dozen trunks a day for one operator and helper is the average, depending upon the size of the trunk.

The air brush is used in practically all modern furniture plants (both metal and wood) today for applying filler, shellac, stain, varnish, primer, enamel, etc. Every product through life from the baby carriage to the casket is air brushed these days.

One modern plant has a complete air brush room of sixteen machines in use for applying lacquer enamel on dolls. This room has a production of approximately 32,000 finished pieces daily and is a good example of the proper layout of an air brush room. Little of the lighting has been obstructed by the installation, and the exhaust equipment complies with the Department of Labor, Division of Hygiene and Sanitation, of the state in which this plant is located.

The air brush is constantly entering new fields of application. Several plants manufacturing large machinery are using the air brush to apply machine fillers, sealers, primers and oil-proof machine paints and enamels. Leather and leather novelty manufacturers are finishing their hides and specialties with the machine. Chandelier and lighting fixture concerns apply the clear lacquer and lacquer enamel finishes that sell their products. Electrical makers use the air brush to apply insulating varnishes and compounds to field coils and motor windings and to lay the japan finish on the motor casting.

Railroads, steamship lines, traction and utility companies, it is claimed, can save from 60 per cent. to 80 per cent. of their painting costs by using the air brush. This saving, in most cases, would be the difference between profit and loss. By comparison, there isn't any other type of equipment obtainable that will show the same percentage of return on so small an initial investment.



Painting structural steel forms becomes a simple and easy operation with the air brush equipment in use.

A THOUSAND AND ONE USES FOR GAS

IN A PAPER under this title, read at the recent annual conference of the British Commercial Gas Association, Mr. Samuel Milne drew attention to the increasing number and variety of industrial purposes for which gas is now used. He claimed that gas had many advantages over solid fuel, such as: (1) Saving of space for storage; (2) saving of space occupied by furnaces; (3) saving of labor for handling fuel, ashes, etc.; (4) reliability of supply and constancy of heat value; (5) economy in fuel usage, no fires burning to waste when no longer required; (6) ease of control of fuel; (7) facility of obtaining high temperature speedily; (8) cleanliness in the factory.

The British Launderers' Research Association has offered employment at the rate of $5,000 a week for a scientist who can reduce the high cost of laundry work. Here must surely be a chance for a compressed air expert.

A newly discovered coal field is reported in Shantung Province, which is said to contain an immense quantity of smokeless coal. Chinese and foreign engineers were engaged in the exploration of the coal field, and the mine is to be developed under Chinese auspices at an expenditure of $500,000.

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EDITORIALS

THE PRICE PAID FOR WASTE IN INDUSTRY

THERE IS AN old saying about watching the spigot and wasting at the bunghole; and the question is at what end of the barrel is American industry more neglectful? That our industries are run in a decidedly heedless fashion has recently been brought to light in a rather disturbing manner; and the facts presented show to the unbiased that there is great room for improvement. Indeed, it is vital that we mend our ways if we expect not only to restore our dollar to full value but to put ourselves in a position to hold our own against foreign competition in all of the markets of the world.

The Committee on Elimination of Waste in Industry, a while back completed an intensive study covering five months of work in which several departments of our varied productive activities were carefully analyzed, and the reconnaissance report has now been made public. Its pages give ample food for thought for all walks of life, because the industries examined touch everyone of us either directly or indirectly. In these days when substantially the whole world is struggling with the problems of economic readjustment and reconstruction in its widest sense, it is a shock to us to learn that our factories, shops, and building trades are carrying on at yearly losses mounting into many hundreds of millions of dollars.

To the man in the street this spendthrift conduct may seem unbelievable; but it is the case just the same, and the high cost of living is in a large measure the reflex of this condition. We pride ourselves upon our capacity to deal successfully with very difficult situations; our engineering cunning has evolved for us many sorts of automatic and labor-saving machines, and the common assumption is that these evidences of our creative capacity are proof likewise of our industrial efficiency. It is not pleasant to be told that our record is quite to the contrary.

HERBERT HOOVER, in a foreword which he has written for the published report of the Committee mentioned, has said: "We have probably the highest ingenuity and efficiency in the operation of our industries of any nation. Yet our industrial machine is far from perfect. The wastes of unemployment during depressions; from speculation and overproduction in booms; from labor-turnover; from labor conflicts; from intermittent failure of transportation of supplies of fuel and power; from excessive seasonal operation; from lack of standardization; from loss in our processes and materials—all combine to represent a huge deduction from the goods and services that we might all enjoy if we could do a better job of it." The men who actually made the surveys have been a good deal more specific, and their figures show just what gaps we must stop and where we must mend our ways if we wish to make the savings which are possible.

The industries studied, and with which the report deals, have to do with the manufacture of men's clothing, the building trades, the metal trades, printing, the production of textiles, and the manufacture of boots and shoes. The experts assigned the discovered losses broadly to management, to labor, and to outside contacts of various sorts; and the measure of responsibility in each case was evaluated in "points" or percentages of the total wastage. What will probably be most astonishing is that the heaviest burden of accountability in each of the industrial groups considered was attributed to inefficient or faulty management.

Broadly stated, the less efficient the management the greater the aggregation of the losses characteristic of the industry. In other words, it would seem that the most pressing of our industrial ills exist in the executive departments of these several businesses. This does not, however, necessarily mean an inherent lack of directive capacity but a pretty general neglect of factors that bear sooner or later upon the financial success of the enterprise; in some cases it represents a failure to watch the dripping of the spigot, and in other instances it amounts to a disregard of the traditional bunghole.

Most of us know that we have magazines, trade publications, and newspapers of many sizes and dimensional proportions. We are told that these variations lay an ultimate tax upon the public of quite $100,000,000 every year; and we are assured that the adoption of a single size for all newspaper columns would bring about an annual saving of from $3,000,000 to $5,000,000 in composition and plates alone. Similarly, standardization in diverse directions in all of the industries would leave our pocketbooks measurably fuller at the end of each twelvemonth.

The high cost of labor turnover is a familiar story, and the Committee's analysis shows why this is so and points to a number of ways by which men can be kept longer on their jobs or shifted to other tasks with a minimum of productive sacrifice. The "greenhorn" is inevitably expensive, because it takes time to train him and usually involves the wastage of valuable materials in the process. Labor turnover can undoubtedly be reduced by making the day's work interesting, and even fascinating.

The Committee has made it plain that proper flow sheets in a good many establishments would cut out lost motion and keep all hands profitably busy during the entire working day. As it is, lack of coördination; lack of uniformity in the supply of materials to the operatives; lack of systematic movement of the evolving commodities; and defective distribution of tasks lead in the end to serious losses. And then we are guilty often of wastefully overequipping our plants, and thus inviting frequent periods of idleness of parts if not the whole of the establishments concerned. For example, it is said that our clothing factories are built 45 per cent. larger than is necessary; our printing houses are from 50 per cent. to 150 per cent. overequipped; the shoe industry has a capacity of 1,750,000 pairs of shoes a day, and produces little more than half that number; and throughout the metal trades standardization of products would allow of a large reduction in plant and equipment.

As might be expected, the Committee dwells upon both the human and the financial sacrifices that are incident to ill health. They tell us that the 42,000,000 men and women gainfully employed in this country lose on an average more than eight days every year through disability due to illness, including non-industrial accidents; and this entails a total productive or service loss each twelvemonth of 350,000,000 days. Inquiry has brought to light that fully 25,000,000 workers have defective vision of sorts calling for correction. Where this matter has been heeded by plant executives it has been found that the correction of sub-standard vision alone brings about a notable increase in the quality and the quantity of the output.

The Federated American Engineering Societies are doing a splendid work through the Committee on Elimination of Waste in Industry; and it is the purpose of the organization to pursue its investigations farther and to give the results to the world. The revelations are of general value aside from their particular application to the departments of industry immediately concerned. They disclose faults or shortcomings which are fairly typical of most of our lines of productive endeavor.

PITY THE POOR PATENT OFFICE

THE ABOVE title would seem to suggest that this is a begging proposition, which it very distinctly is not. It is not easy to understand what is the matter with the United States Patent Office, or rather with those who are responsible for its maintenance and continued operation. We know more or less what an efficient agent it has been in the upbuilding of the nation's industrial and commercial growth and wide prosperity. Inventions, and chiefly those of our own people, have been the chief stimulators and sustainers of not only our manufacturers but of all our productive activities. They have been the chief developers and promoters of employment and have cheapened and increased the variety of our products. Especially has the farmer benefited by the invention of improved machinery and methods, which have increased his output and reduced his necessary expenditure while extending his market.

Members of the Congress, in both houses, individually know these things as well as anybody, but who would think it. The Patent Office, in the details of its management and in the provisions for its financial support, is unfortunately dependent upon the more or less capricious action—or inaction—of Congress. As a result the office is being starved or frozen out and its most valued and necessary officials are taking the hint that they are not wanted and are continually leaving this more than neglected institution.

The essential qualifications of a patent office examiner are not to be compared with the requirements to fill an ordinary clerical position. The examination of a postal clerk, for instance, covers only the subjects of a common school education and is easily disposed of in a day. An assistant examiner's examination takes three days. He must show his knowledge of the higher chemistry, mathematics, physics, of technics including applied chemical, mechanical and electrical science. He must read mechanical drawings and must know one foreign language. His annual salary is one hundred dollars more than that of the postal clerk and the salary of an examiner has been raised only ten per cent. since 1848, which history tells us was just after the Mexican war.

In thirty-two months 231 of 437 examiners resigned, more than a half, and we know as they knew that they would get much higher incomes outside. The work of the office is woefully in arrears. Commissioner NEWTON told the House Committee on Patents two years ago last July that he had been in the Patent Office since 1891, and he was "sure that the office was never in so poor a condition as it is now." But the condition is worse now; Mr. ROBERTSON, the present Commissioner calls it "deplorable."

A bill before the House to provide better pay (H. R. 7077), "Mr. MONDELL," says the New York Times, "Republican floor leader, is bent on choking or delaying, while the bill for the classification of civilian positions (H. R. 8928), a measure swarming with contentious matter is under way. That is, the Patent Office must be starved for nearly two years more. Why doesn't Mr. MONDELL introduce a bill directly to encourage unemployment? To strengthen the Patent Office is to relieve labor and business. The House should do it at once."

PRESENT STATUS OF THE METRIC SYSTEM

IT IS NOT easy to find any published matter concerning the metric system which is not distinctly committed to the advocacy of one side or the other and too evidently disposed to set in the most unfavorable light whatever may be offered in opposition or rebuttal. The following, which we reproduce from Research Report No. 42, of the National Industrial Conference Board, is an interesting contribution to the general discussion and in it there is no apparent purpose to blindfold those whom it would lead.

The situation in the United States, is today quite different from the situation that confronted other important countries in making a change from their local systems to the metric. In other countries considerable confusion of weights and measures existed at the time the change was brought about. In other countries, also, the change took place before the industrial life of the nation had become organized and standardized to the extent that modern production makes necessary. The countries outside of Europe which have adopted the metric system have little or no organized industries in the modern sense.

In the United States today there is, in the first place, no fundamental confusion with respect to weights and measures. Furthermore, the United States unquestionably stands in the forefront of the great industrial and manufacturing nations. Its highly organized industry is based on the English units of weight and measure and most of its vast technical literature is written in this system. All things considered, therefore, there does not exist in this country the great incentive to a change found in other nations where confusion was the rule until the metric system was adopted.

In consequence the situation today narrows itself down to the question whether the advantages to be gained warrant the *compulsory* adoption of one unified system, namely, the metric, in the place of another unified system, namely, the English, which latter is moreover the established system and enters so intimately into the present industrial organization of the nation. It is not a question of allowing the use of the two systems side by side and giving the metric the opportunity of supplanting the English, because the metric has, as a matter of fact, been a legal system in the United States since 1866, and anyone who so desires and finds it more convenient and practical may use it. The question is, shall the United States discard the English system in weights and measures entirely and absolutely and in its place substitute by *compulsory* law the metric system as the sole standard?

AIR USED IN DRIVING SHIELDS FOR VEHICULAR TUNNEL

As will be recalled, the plans for driving the shields for the Hudson River Vehicular Tunnel involve, first, the sinking of two caissons at either end of the undertaking and, next, using these structures as bases of operation in placing the tubes. At first, it might be thought that this would entail active work at eight headings, four advancing from opposite shores toward the center of the stream and four others working inland and upward to the approaches or portals. As a matter of fact, physical conditions are not identical at the New York and the New Jersey ends of the project. That is to say, the work inland from the Manhattan caissons will be prosecuted by the cut-and-cover method, and shields will be driven only in the direction of and beneath the river. Therefore, there will be but six headings.

According to the engineering specifications, the contractor or contractors will be expected to provide compressed air plants capable of furnishing low-pressure air for each heading to the measure of 14,000 cubic feet per minute. This will necessitate a total volume of 84,000 cubic feet per minute for the six headings. Plainly, the compressor equipment will be of rather impressive proportions. In addition to this, there must be furnished ample air for a high-pressure system from which energy will be tapped for the functioning of air drills and other pneumatic tools. It seems that the routes chosen for the twin tubes will necessitate the penetration of 1,300 feet of rock on the Manhattan side.

DISTRIBUTION OF AMERICAN MANUFACTURES

A MATTER that is of considerable general interest among all classes of the people is the geographical location of our various industries and the causes which are responsible for their present distribution over various sections of the country. Among these causes which could be listed are the source of raw product, destination of finished material, transportation conditions, power facilities, available labor supply and a great many others pertaining to any specific manufacturing enterprise.

However in this connection a summary of products manufactured in the United States has been prepared by the National Industrial Conference of New York which presents figures, based on the value of the product prepared from the 1919 census and shows the territorial distribution of the manufacturing industry

According to this analysis it appears that New York State maintains its leadership with a credit of 14.1 per cent. of the total valuation of manufacturing output. Pennsylvania comes next with 11.6 per cent. Then follow, in order, Illinois, with 9.3 per cent.; Ohio, with 8.1 per cent., and Massachusetts, with 6.4 per cent. The big surprise in this list of industrial leaders, the board says, is the prominence of Illinois and Ohio, both of which lead the great manufacturing State of Massachusetts.

The group next in industrial importance consists of states which produce from about six per cent. to about two per cent. each of all manufacturing value. This group is headed by New Jersey, in the following order; New Jersey, 5.9 per cent.; Michigan, 5.5 per cent.; California, 3.2 per cent.; Indiana, 3 per cent.; Wisconsin, 3 per cent.; Maine, 2.5 per cent., and Connecticut, 2.2 per cent. One of the most remarkable things about these figures, the board finds, is that they run so nearly parallel to those of the 1899 census.

INVENTOR AND INVESTOR BROUGHT TOGETHER

TO BRING the inventor and the investor together and to act as a general clearing house for constructive ideas, an association of inventors, engineers, scientists and financiers has recently been formed under the presidency of Dr. Miller Reese HUTCHISON, former chief engineer to Thomas A. EDISON. The association will seek to protect the inventor in the development and marketing of his ideas, and also to safeguard the investor in the use of his money by the thorough testing out by a group of experts of every idea accepted. The directors of the association include Hudson Maxim, Rear Admiral Samuel McGowan, Paymaster General, U. S. N., retired, and Sir Edgar Rees Jones, M. P., head of the Priorities Division of the British Ministry of Munitions during the war and who will act as European Director.

Every invention must come to Miller Reese HUTCHISON, Inc., as the association is called, with the endorsement of an engineer in good standing. It will then be passed upon by the technical staff and submitted to outside experts for report on the possible commercial demand, the integrity of the theories embraced, its patentability and the validity of the title. Every device accepted for development will be thoroughly designed on paper before expending any money on machine work. A model will be made and tested to uncover unforseen weaknesses. Dr. HUTCHISON is the inventor of the acousticon for aiding the deaf, of the Klaxon horn, and several hundred patents.

An important achievement of the new organization was recently demonstrated when a miniature model of a new type of "supergun," similar in size to a pneumatic hammer, shot a steel bullet three inches long and a half inch in diameter through a three-quarter inch steel plate at a velocity of a mile a second. There was no percussion and no recoil and the report was no greater than the click of a cash register. When developed to its full power, it is claimed the gun may be capable of hurling a projectile at a velocity of five miles a second and of hurling a several tons projectile several hundred miles.

THE MOST COSTLY METHOD OF OIL DISTILLATION

The distillery process without the worm is only half done, which makes it so costly. An investigation of losses in crude oil through evaporation in storage and in transportation, conducted during the year by the Bureau of Mines, disclosed losses of startling magnitude. It was found that in the few days in which crude oil is stored on the lease before being taken by the pipe line, the aggregate loss per year from evaporation amounts to about 122,000,000 gallons of gasoline in the Mid-Continent field alone. This has a value, at 22 cents per gallon, of $26,840,000, and represents about three per cent. of the total gasoline produced in the United States from all fields and all sources. The bureau found that a large per cent. of this loss could be prevented by the use of efficient equipment.

The largest lift and turn over type of car dumper in the world was installed during 1921 at the docks of the Western Maryland Railroad in Baltimore. This dumper is Westinghouse equipped and has a capacity of unloading fifty 100 ton capacity cars per hour. The grain car dumpers at the Pennsylvania R. R. Pier at Baltimore are also of unusual magnitude. Four of these machines with an operating crew of eighteen men can unload 400 cars daily, each car containing from 1200 to 2000 bushels of grain.

Secretary of Commerce Herbert Hoover recently made the interesting statement, which is very astonishing and would seem to be incredible, that he was only the second engineer in the 155 years of the history of the United States to hold a high office under the Government, George Washington having been the first. Probably he could not have told the number of lawyers.

The United States possesses the largest known deposits of molybdenum ores, but is relatively poor in high-grade deposits of some other important alloying elements used in alloy structural steels, such as automobile steels. Nickel, chromium and vanadium are the standbys in present-day alloy steels. Of these, we have very little nickel; some chromium, mostly in relatively low-grade ores; and only small deposits of vanadium. It is of utmost importance to know to what extent molybdenum can replace any of these elements. Moreover, there is as yet comparatively little market for molybdenum.

The new Gilboa reservoir on the headwater of the Schoharie river in the Catskills, which is being built to supplement New York City's Catskill water supply, will have an area of 1170 acres. It will be 5.8 miles long, from 0.3 to 0.7 of a mile wide, and its average depth will be 57 feet. It will store 22,000,000,000 gallons of water from a watershed of 314 sq. miles, upon which average rainfall since 1907 has been 40 inches annually. This total rainfall, if it could all be collected, would represent about ten times the above computed reservoir capacity.

The Engineering Institute of Canada is taking steps to make the engineering profession a closed one, which means that no one would be allowed to do engineering work unless he was a member of the Engineering Institute of Canada, and membership in that body is made contingent upon the applicant for admission holding a degree from a qualified school of science.

In connection with the preparation of a bulletin on flame safety lamps there have been collected at the Pittsburgh Experiment Station about 110 flame safety lamps representing about 50 different patterns.

At the present time one-half of the zinc output of the country, in the form of zinc oxide, is being used by the tire manufacturers. The warehouse stocks of tires now total 3,500,000 as against 10,000,000 a year ago, so there must soon be some lively work to catch up.

Utilizing compressed air and a new form of sound box, a British invention has brought out a phonograph that is said to equal in intensity the volume of sound of a full band.

In the course of reopening the old silver mines of Hecla, Beaverhead County, Mont., the Cleave shaft is being unwatered. Recently the station pump was reached, cleaned and started after having been submerged for seventeen years as though it had been shut down over night only. It pumps against a head of 600 ft.

Apparatus for finding the height of the clouds for the information of night-flying airmen is to be tried at the London Air Station, Croydon. It consists of a 500,000 candle-power searchlight throwing a vertical beam upon the clouds, and a specially designed theodolite through which to observe the point where the beam touches the cloud. The angle obtained and the distance of the theodolite from the searchlight are all that the observer needs to find the height of the cloud.

A device that blows the fire horn to let the people of Amityville, L. I., know that there is a fire in the village caught fire itself recently, but succeeded in emitting the necessary noises that brought the fire department to its rescue. The contraption is the latest thing in fire alarms, automatically providing itself ahead of time with sufficient compressed air to sound off even after it goes wrong itself. The blaze was caused by the short-circuiting of a motor, and was easily extinguished. It is located in the rear of the hose company's house.

MINING IN LITERATURE

One can hardly get much further back than the Book of Job, in the twenty-eighth chapter of which the operation is described in surprising detail. The writer tells of a district—probably Sinai or Egypt—where "iron is taken out of the earth and copper is molten out of the stone. Man setteth an end to darkness"—carrying his light down the mine or shaft—"and searcheth out to the furtherest bound the stones of thick darkness"—a description which would be suitable for coal. The sinking of the shaft is described: "He breaketh open a shaft away from where men sojourn; they are forgotten of the foot that passeth by. They hang afar; they swing to and fro"—as they descend into the bowels of the earth. The ninth verse suggests an anticipation of blasting long prior to the days of explosives. Then there is an illusion to the cementation process in the next verse: "He bindeth the streams that they trickle not."

Africa, nearly four times as big as the U. S. has a railway mileage but twelve per cent of that of the United States; and Asia, nearly six times as big as the United States, has only one-fourth the railway mileage of this country.

BOOK REVIEWS

THE MANUFACTURE OF PULP AND PAPER (Vol. 1), by J. J. CLARK, M. E. 132 pp. New York: McGraw-Hill Book Company.

THIS IS A textbook of modern pulp and paper mill practice prepared under the direction of the joint executive committee on Vocational Education representing the pulp and paper industry of the United States and Canada. It is the first volume of five, prepared under direction of the above committee, to cover the processes employed in that industry and bring together the fundamental subjects of mathematics and elementary science and the principles and practices of pulp and paper manufacture.

The complete work is conveniently divided into sections and bound into volumes for reference purposes, and is also available in pamphlet form for home and class room study. Volume I treats of the elementary mathematics and physics of pulp and paper mill practice.

ANNUAL REPORT OF THE SMITHSONIAN INSTITUTION for the year 1919. Illustrated. 557 pp. Government Printing Office, Washington, D. C.

ALL WHO ARE attracted by scientific progress will find this latest report of the Institution as full of interesting and valuable information as have been the preceding volumes. Besides covering the operations, expenditures and conditions of the Institution, the report is enriched with a miscellaneous selection of papers embracing a considerable range of scientific investigation and discussion. These papers, many of them original, illustrate the more remarkable and important developments in physical and biological discovery during that period. A wide variety of topics are discussed, ranging from Deflection of Light, Wireless Telephony, Radium and the Electron to Etymology and the War, The Exploration of Manchuria, and many other interesting subjects.

THE CENTURY VOLUME OF CHARLES GRIFFIN AND COMPANY, LTD., PUBLISHERS, 1820-1920, with Foreword by Lord Moulton, 310 pages, 6 by 9 in. More than 40 illustrations mostly full-page. Charles Griffin and Company, Ltd., 12 Exeter Street, Strand, London. J. B. Lippincott and Company, Philadelphia.

THIS exceptionally handsome volume, liberally illustrated and beautifully printed, worthily commemorates the completion of a century of prosperous activity of one of the leading houses devoted to the publication of high-class works in English. These publishers from the beginning set themselves not to cater to the changing tastes of the people, as in fiction and light reading, but to provide for the developing practical requirements of the age, and accordingly over 90 per cent of its publications are technical and scientific text books, manuals and monographs.

The successive chapters of the book, each by a separate writer of eminence, not only give the story of the life and growth of the firm and incidentally something of the careers of contemporary publishers and much of the history of the city of Glasgow, but also bring out the successive advances and developments in the various departments of science, ranging from the most speculative to the most practical, the prominent leaders in thought and practice coming into view one after another as the years rolled on. The book is intrinsically valuable not only for present perusal but for permanent record. Its place is among the best books of the best libraries.

AIR BRAKE CATECHISM BY ROBERT H. BLACKALL. Twenty-eighth edition, revised to date. Illustrated with detail drawings and colored plates. 411 pp. Cloth $2.50 net. New York: The Norman W. Henley Publishing Co.

THE FACT THAT this is the 28th edition of this book indicates that there is an urgent demand for a book of this nature written on the question and answer plan, making it convenient to locate particular points upon which information is desired.

The air-brake art has almost completely changed in the last few years, hence the need for an entirely new edition. Longer trains, heavier cars and greater locomotives have made imperative some radical changes in the air brake. To meet these changed conditions in train service the Westinghouse Air Brake Company has developed new engine and car equipment which this new edition covers in detail.

"The Scientific Selection of Explosives for Coal Mining" is the title of an illustrated pamphlet received from the Hercules Powder Co. and which presents considerable interesting and valuable information for the coal mining industry. The pamphlet has been prepared from a paper delivered by Mr. U. S. Greensfelder of the Hercules Powder Co. at the Coal Mining Institute, Pittsburg, December 8th, 1921. It brings out the various important points which should be considered in choosing the explosive most desirable for any particular set of conditions.

"Compressed Air," Frank Richards' first book on the subject, after being in the market a quarter of a century is now out of print, the plates having been broken up. When this book first appeared *The Engineer*, London, in a review of it made the unusual remark that "it was written by the author." "Compressed Air Practice," the second book by Frank Richards, which followed the other a score of years later and is still flourishing, has also that "written by the author" flavor about it as perhaps its most striking characteristic. The book first mentioned, by the way, gave to the world the general air compression table which has been the standard ever since in Engineers Pocket Books and elsewhere and has not been superseded.

The fluctuations in the price of oil do not trouble the pipe-line companies. They are generally engaged exclusively in the transportation of oil at a certain rate per barrel.

Silas Wright Titus, a man with a record which must be called unique, died in Brooklyn, Jan. 7, 73 years old. He was a grandson of the first mayor of Syracuse, N. Y., where he was born. As a young man he developed phenomenal skill in discovering underground water and in building wells and water works plants. These projects he carried out in many states. He also had patented seven devices for raising water by air. He contracted to supply the City of Brooklyn with 10,000,000 gallons a day, found the water, built a plant at Jamaica and sold it to the city for $337,000.

* * *

W. C. Starkey for several years chief engineer of the Ohio Brass Co., Mansfield, O., became vice-president and directing engineer of the Stevenson Gear Co., Indianapolis, Ind., on Jan. 1.

* * *

Mr. R. B. Stringfield, who has been chemical engineer for the Los Angeles plant of the Goodyear Tire & Rubber Co., has been transferred to the chemical department at Akron, Ohio.

* * *

Thomas Murray, director and assistant secretary of the United States Steel Corporation, died at his home in Sparkill, N. Y., recently. Judge Elbert H. Gary, chairman of the board of directors of the company, paid him this tribute: "He was a man of high character, more than ordinary ability, trusted and beloved by all his associates in the Steel Corporation."

Mr. Murray was born in Jersey City, Dec. 14, 1867. He attended public and high schools in Jersey City. At fourteen he took up the study of law. Mr. Murray became connected with the Federal Steel Company in 1894 and was appointed assistant secretary of the United States Steel Corporation upon its organization in 1901, which position he held at the time of his death. In 1919 he was appointed assistant treasurer of the corporation. He was a director also of many of the subsidiary companies of the corporation.

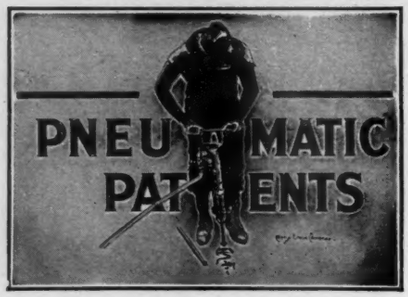
* * *

Mr. R. W. Woodward has been appointed metallurgist at the plant of the Whitney Manufacturing Co., Hartford, Conn.

* * *

John Wheeler Duntley, 55 years old, founder of the Chicago Pneumatic Tool Company, was killed recently by an automobile truck.

Mr. Duntley was one of the first men to bring pneumatic tools into use, working with Charles M. Schwab to place them on the market. He began his business career as a foundryman. He established the Chicago Pneumatic Tool Company in 1884, and was president until 1909. He was director of the Taite-Howard Pneumatic Tool Company of England and head of the Duntley Automobile Accessories Company.



OCTOBER 11

1,393,066. WATER-TRAP FOR AIR-LINES. Charles E. Atkinson, South Bend, Ind.
1,393,085. COMPRESSOR. Allan O. Carpenter, Corning, N. Y.
1,393,207. OIL-BURNING APPARATUS. Francis I. du Pont, Wilmington, Del.
1,393,226. COOLING APPARATUS. Henry E. Leavitt, Berkeley, Calif.

1. In a cooling apparatus, a chamber for containing material to be cooled, a partition of porus material extending across the top of and directly exposed throughout to the interior of said chamber, means for supplying moisture to said partition, means spaced from said partition and independent of said chamber for forming with said porous partition a vacuum chamber, a vacuum pump communicating with said vacuum chamber and means for operating said pump.

1,393,240. PULVERIZED - FUEL - BURNING LOCOMOTIVE. John E. Muhlfeld, Scarsdale, N. Y.
1,393,280. BURNER-REGULATION SYSTEM. John Good, Garden City, N. Y.
1,393,382. PNEUMATIC ALARM. Samuel Kushner, New York, N. Y.
1,393,387. MILKING-MACHINE SYSTEM. Herbert McCornack, Glen Ridge, N. J.
1,393,514. PNEUMATIC VEHICLE-WHEEL. Adolph W. Eckhardt, New York, N. Y.

OCTOBER 18

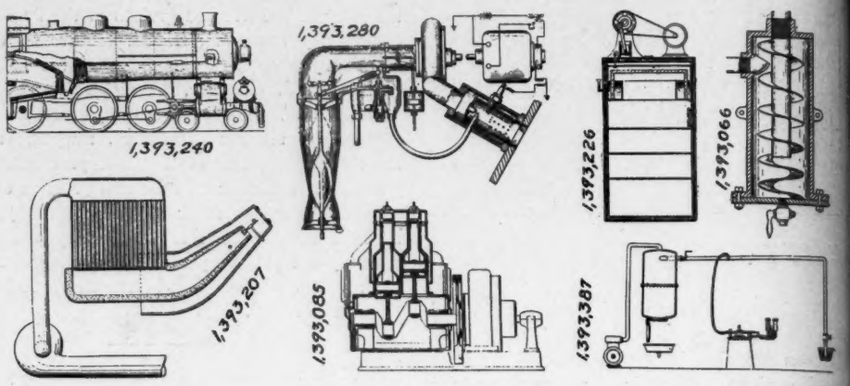
1,393,781. MILKING-MACHINE. Palmer B. Hewlett, Hollister, Calif.
1,393,852. PNEUMATIC DRILLING-MACHINE. John Wilbur Tierney, Ashtree, and Frank Hills, Upton, London, England.
1,393,856. MEASURING DEVICE FOR SEMI-LIQUIDS. Ernest T. Upright, Fresno, Calif.
1,393,894. SYSTEM OF RAISING SUNKEN SHIPS. Daniel F. McGill, Portland, Oreg.
1,393,937. OIL-BURNER. Frank Beu, Chicago, Ill.
1,394,104. WINDMILL-POWER ENGINE. Stanley E. Martin, Bloom, Kans.
1,394,377. BURNER FOR GAS AND OIL. Cornelius P. Vallely, Bradford, Pa.

OCTOBER 25

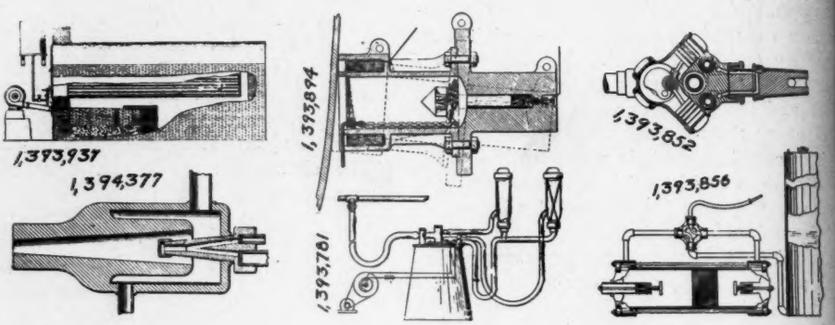
1,394,576. LIQUID-FUEL BURNER. Hale W. Parrish, Chicago, Ill.
1,394,802. UNLOADING APPARATUS FOR COMPRESSORS. Wade H. Wineman, Chicago, Ill.
1,394,811. COMPRESSOR. Gaston Jules Daloz, Courbevoie, France.
1,394,819. COMPRESSOR - CONTROLLING MECHANISM. Alexander D. Ferguson, Chicago, Ill.
1,394,824. LIFE-SUSTAINING APPARATUS. Petar Habrich, Philadelphia, Pa.
1,394,859. AIR MOISTENING AND DISTRIBUTING DEVICE. Charles W. Mosher, Cattaraugus, N. Y.
1,394,924. PORTABLE AIR COOLER, MOISTENER, AND PURIFIER. Bernarr MacFadden, New York, N. Y.
1,394,940. SUCTION-CLEANER. William W. Rosenfield, White Plains, N. Y.
1,395,221. AIR-BRAKE SYSTEM. Henry Allie Bryan, Madill, Okla.

NOVEMBER 1

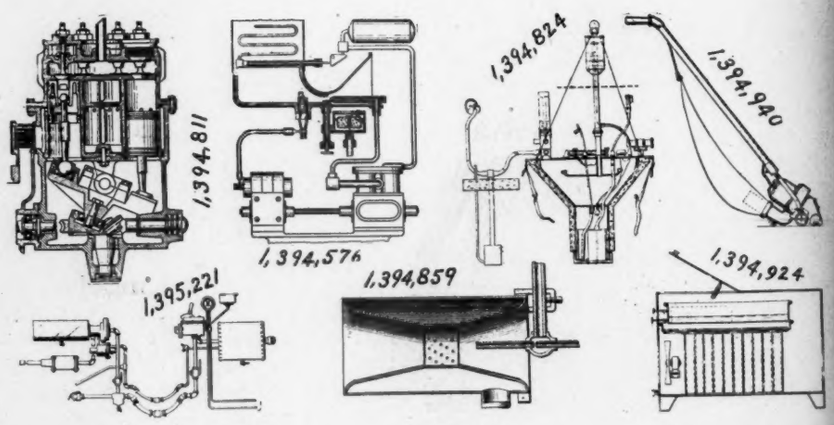
1,395,368. DISPENSER FOR COMPRESSED AIR. Gregory John Spohrer, East Orange, N. J.
1,395,382. SEED-COTTON CLEANER. Charles C. Biggerstaff, Rowesville, S. C.
1,395,438. AIR-SPRING SUSPENSION. Richard Liebau, New Haven, Conn.
1,395,537. COMBINATION-BLOWPIPE. George L. Walker, New York, N. Y.
1,395,546-7. AIR-PUMP. Carl E. Anderson, Maywood, Ill.
1,395,915. VACUUMIZING APPARATUS. George B. Haines, Chicago, Ill.
1,395,954. VENTILATING SIGNAL APPLIANCE FOR MINES. James F. Gamille, Fredericktown, Pa.



October 11.



October 18.



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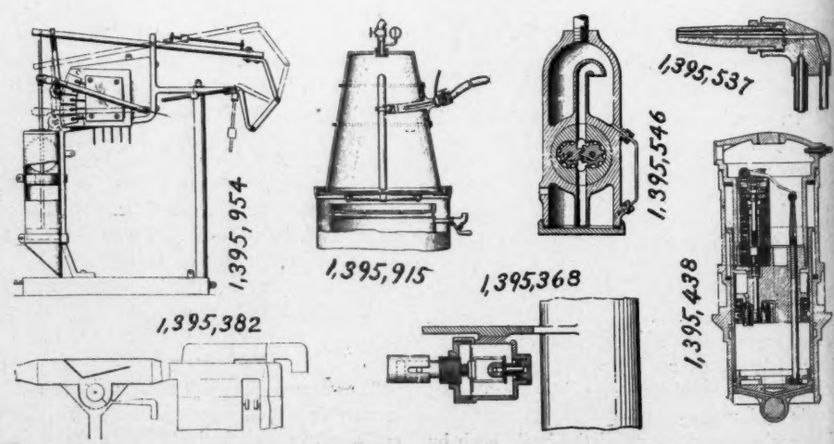

November 1.